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Long-Term Management Strategy for Dredged Material Disposal for Naval Facilities at Pearl Harbor, Hawaii

Phase I – Formulation of Preferred Disposal and Management Alternatives

Paul R. Schroeder and Michael R. Palermo

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Preface

This report describes existing management options and data for disposal of dredged material from the Pearl Harbor Naval Complex (PHNC). This work was conducted by the Environmental Laboratory (EL) of the U.S. Army Engineer Research and Development Center (ERDC). Funding was provided by the U.S. Navy, Naval Station, Pearl Harbor, under Project Orders N6281397MP29002 and N6281398MP23001. The project manager is Ms. Suzanne Baba of Pacific Division, Naval Facilities Engineering Command.

This report was written by Dr. Paul R. Schroeder and Dr. Michael R. Palermo, both of the Special Projects Group, Environmental Engineering Division (EED), EL. Cost estimating was performed by the U.S. Army Corps of Engineers District, Portland, Construction & Operations Division (CENWP-CO-NWC). Appendix A of this report was prepared by Ogden Environmental and Energy Services Co., Inc. for a previous Navy study and is included here for completeness. Appendix B of this report was prepared by Mr. Ken Espenel, CENWP-CO-NWC, Dr. Schroeder, and Mr. Jerry L. Miller of the Environmental Resources Engineering Branch (EREB), EED, EL. Technical editing was performed by Ms. Cheryl M. Lloyd, EREB, EED, EL. Technical review of this report was provided by Mr. Daniel E. Averett of the Environmental Restoration Branch, EED, EL, and Mr. Thomas R. Patin, EREB, EED, EL.

This study was conducted under the direct supervision of Mr. Norman R. Francingues, Chief, EED, and under the general supervision of Dr. John Keeley, Acting Director, EL.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4046.873	square meters
cubic yards	0.7645549	cubic meters
feet	0.3048	meters
inches	2.540	centimeters
knots	0.5144444	meters per second
miles (U.S. statute)	1.609347	kilometers
miles (U.S. nautical)	1852.000	meters
pounds per cubic foot	16.01846	kilograms per cubic meter

Long-Term Management Strategy for Dredged Material Disposal for Naval Facilities at Pearl Harbor, Hawaii

Phase I - Formulation of Preferred Disposal and Management Alternatives

1 - Executive Summary

The purpose of this report is to document an evaluation of existing management options and data for disposal of dredged material unsuitable for ocean disposal from the Naval Station, Pearl Harbor, on the island of Oahu for the next 30 years. This evaluation includes a review of dredging volumes and frequencies, dredging and disposal equipment and techniques, environmental resources, and disposal alternatives/management options presently available. This evaluation is Phase I of a more comprehensive approach in developing a workable Long-Term Management Strategy (LTMS).

Dredging is required in both operational areas and in the main navigation channels. Sediments unsuitable for ocean disposal are primarily in the operational areas. About 30% of the sediments from the operational areas appears to be unsuitable for ocean disposal based on a remedial investigation (RI) findings on toxicity of surficial sediments and another 30% may also be marginally unsuitable based on RI study findings on reduced fertilization (Ogden Environmental 1996). Similarly in the main navigation channels only 5% of the sediments to be dredged appears to be unsuitable for ocean disposal and another 10 to 15% of the sediments appear to be marginally polluted. Sediment from upper areas of Pearl Harbor is primarily fine-grained lagoonal silt with clay while sediment from lower channels is primarily sand. Previous chemical analyses performed on the sediments indicated the presence of low concentrations of metals and some organic contaminants. Dredging of the operational areas, averaging 75,000 cu yd* per year, has typically been performed by mechanical clamshell dredges. Previous maintenance dredging

* A table of factors for converting non-SI units of measurement to SI units is presented on page vi.

of the main channels, averaging 200,000 cu yd per year, has been performed by the hopper dredge *Essayons*. For a 30-year LTMS period, the total required disposal volume for unsuitable material could be as large as 1,600,000 cu yd. In addition, the alternative should be able to handle up to 300,000 cu yd in a single year.

Ten disposal alternatives, including contained aquatic disposal, upland or nearshore confined disposal, and beneficial uses alternatives, are identified for material that is unsuitable for ocean disposal. Several of the alternatives by themselves can provide adequate capacity for the next 30 years. The costs of the alternatives are a function of the alternative; some are somewhat higher than open-water disposal, while others are much higher. Most of the alternatives would have high public acceptance and low environmental impacts. Upland disposal in a 124-acre confined disposal facility (CDF) on Waipio Peninsula would be the least costly and the most technically feasible and implementable alternative that can accommodate the disposal requirements for the next 30 years or longer. Other alternatives which provide for beneficial use of the dredged material would typically require an upland disposal site as a storage and preparation area prior to implementation of the beneficial use; the Waipio Peninsula alternative could also serve these requirements. Due to the cost of developing the Waipio CDF it may take a number of years to implement the alternative. An interim smaller CDF (300,000 cu yd) adjacent to the reef runway at the Honolulu Airport could provide a short-term solution for immediate dredging requirements.

Based on the results of this Phase I effort, it is recommended that Phase II be initiated to evaluate the Waipio Peninsula and Reef Runway disposal alternatives. Phase II will consist of environmental and engineering studies including laboratory testing and modeling, determination of design parameters and operating conditions, and identification of data deficiencies.

2 - Introduction

Background

The Naval Station (NAVSTA), Pearl Harbor, dredges a number of locations throughout the Pearl Harbor Naval Complex (PHNC) intermittently to maintain harbor operations. A general layout of the Pearl Harbor channels and facilities is shown in Figure 1. The quantity of sediments dredged totals as much as a million cubic yards every five to seven years. Up to the present time all of the dredged material has been disposed in the ocean. Recent testing of some sediments has indicated that some of the material is unsuitable for ocean disposal because of potential impacts from contaminants present in the sediments. Presently, more than 100,000 cu yd of sediment at NAVSTA Pearl Harbor docks have been identified as unsuitable for ocean disposal. Additional sediments in other areas of operations are also expected to be unsuitable for ocean disposal.

The recent finding that some of the dredged material is unsuitable for ocean disposal necessitates finding other disposal alternatives that are practicable, economical, and environmentally sound. These alternatives should provide disposal solutions for the next 30 years and maintain the future viability of naval operations at Pearl Harbor. Investigations of alternatives require development of a long-term management strategy (LTMS) and evaluation of the environmental effects of various disposal alternatives. The Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM) has tasked the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center to develop the LTMS for PHNC.

Objective and Scope

The overall objective of this study is the development of an LTMS for disposal of Pearl Harbor dredged material unsuitable for ocean disposal. The LTMS will identify needs for additional disposal alternatives including quantities and frequencies of use; will formulate alternatives to accommodate the needs; and will apply the findings of detailed screening procedures. Integral parts of this development are (a) the environmental evaluation of dredged material disposal alternatives through the use of screening tools, laboratory testing, and modeling and (b) the determination of the need for imposing restrictions (operational controls, treatment, or structures) on the disposal alternatives. Evaluation of environmental effects will be performed by executing detailed

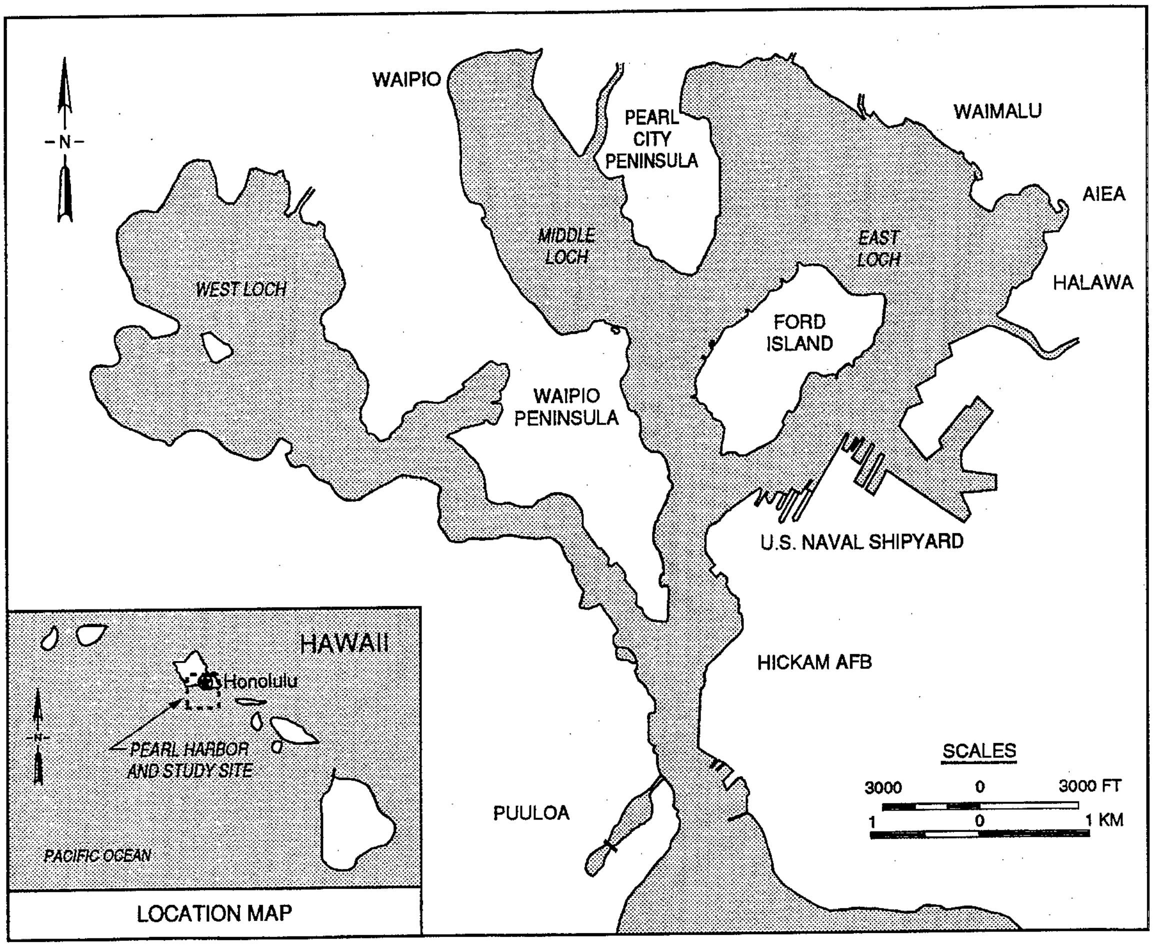

Figure 1. Layout of Pearl Harbor facilities and channels

screening procedures using Tier 1, Tier 2, or Tier 3 approaches as outlined in "Estimating Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediments," Assessment and Remediation of Contaminated Sediments (ARCS) Program EPA 905-R96-001 (Myers et al. 1996). The approaches to be employed for the disposal alternatives are outlined below.

Tier 1 procedures apply sediment physical and chemical characteristics, management and operations data, and conservative literature contaminant release parameters to contaminant releases from the suite of contaminant pathways. Tier 2 employs sediment physical and chemical characteristics, management and operations data, and chemically based laboratory testing emulating the exposure mechanism. Tier 3 employs sediment physical and chemical characteristics, management and operations data, and biologically based laboratory testing emulating the exposure mechanism. Separate procedures are applied to each contaminant pathway, including water column impacts from initial release including toxicity and bioaccumulation, effluent, runoff, leachate, plant uptake, upland and aquatic animal uptake, and volatilization.

The scope of the study consists of three phases:

1) development of viable alternatives taking into consideration cost, existing technology, logistics, environmental concerns, and regulations;

2) evaluation of viable alternatives from Phase I by applying screening tools, performing laboratory tests, and numerically modeling the alternatives; and

3) analysis and report of evaluation findings as an LTMS report that includes preliminary design, size, need for restrictions and controls, and operations/ handling requirements of the recommended and viable alternatives identified by Phase II evaluations.

The LTMS report will support an Environmental Impact Statement or Environmental Assessment by describing the direct environmental impacts of the selected disposal alternatives.

The purpose of this report is to document (a) the viable alternatives available for disposal of Pearl Harbor Naval Station dredged material unsuitable for ocean disposal, (b) the formulation of preferred disposal and management alternatives for further evaluation in Phase II of this LTMS study, and (c) the recommendations for Phase II testing. This report includes a review of dredging volumes and frequencies; dredging and disposal equipment and techniques; environmental resources; and capacities, costs, and logistics of potential disposal alternatives. This report documents the findings, conclusions, and recommendations of Phase I of the comprehensive approach being taken to develop a workable LTMS.

Regulatory Overview

Regulation of dredged material disposal within waters of the United States and ocean waters is a complex issue and is a shared responsibility of the U.S. Environmental Protection Agency (EPA) and USACE. The regulatory overview provided in this section is taken primarily from the USACE/EPA Technical Framework for evaluation of the environmental aspects of dredged material management alternatives (USACE/EPA 1992).

The primary Federal environmental statute governing transportation of dredged material to the ocean for purpose of disposal is the Marine Protection, Research, and Sanctuaries Act (MPRSA), also called the Ocean Dumping Act. The primary Federal environmental statute governing the discharge of dredged or fill material into waters of the United States (inland of and including the territorial sea) is the Federal Water Pollution Control Act Amendments of 1972, also called the Clean Water Act (CWA). All proposed dredged material disposal activities regulated by the MPRSA and CWA must also comply with the applicable requirements of National Environmental Policy Act (NEPA) and its implementing regulations. In addition to MPRSA, CWA, and NEPA, a number of other Federal laws, Executive orders, etc., must be considered in evaluation of dredging projects. An overview of MPRSA, CWA, and NEPA is given in the following paragraphs.

Jurisdiction of MPRSA and CWA

The geographical jurisdictions of the MPRSA and CWA are a function of the location of the proposed disposal site. Disposal at sites located within the baseline defining waters of the United States is regulated under the CWA. This would include open-water placement of material in estuaries, rivers, lakes, as well as placement in CDFs. Also, many beneficial-use applications, such as wetland creation, are regulated under CWA. The baseline is generally defined by the mean lower low water line along the coast, crossing the mouths of estuaries and openings to entrance channels and connecting the seaward limits of islands. The MPRSA regulates the transportation of dredged material in ocean waters, but as a practical matter, the law also regulates the disposal operation. Disposal at sites beyond the limit of the territorial sea (usually defined as the 3-mile limit) is regulated by MRPSA. An overlap of jurisdiction exists within the territorial sea (between the baseline and 3-mile limit). The precedence of MPRSA or CWA in the area of the territorial sea is defined in 40 CFR 230.2 (b) and 33 CFR 336.0 (b), and is a function of the intended purpose of the placement. If material is placed in this area for purposes of disposal, the activity is regulated by MPRSA. If material is placed in this area for other purposes such as beach nourishment, shoreline protection (as in a subaqueous stable for beach feeder berm) or for beneficial uses such as for island creation or aquatic habitat development, the activity is regulated under the CWA. Additional information on the geographical jurisdiction of the MPRSA and the CWA is given in 33 CFR 335-338.

For the island of Oahu, the baseline essentially corresponds to the shoreline. The EPA-designated South Oahu Disposal Site lies beyond the 3-mile limit; therefore, disposal of dredged material at the EPA-designated South Oahu Disposal Site is regulated under MPRSA. Dredged material from Pearl Harbor suitable for ocean disposal may be disposed at the EPA-designated South Oahu Disposal Site. Any disposal of dredged material within Pearl Harbor waters or in CDFs would be regulated under the CWA.

Overview of MPRSA

Section 102 of the MPRSA requires EPA, in consultation with USACE, to develop environmental Criteria that must be complied with before any proposed ocean-disposal activity is allowed to proceed. Section 103 of the MPRSA assigns to the USACE the specific responsibility for authorizing the ocean disposal of dredged material. In evaluating proposed ocean-disposal activities, the USACE is required to apply the Criteria developed by EPA relating to the effects of the proposed disposal activity. In addition, in reviewing permit applications, the USACE is also required to consider navigation, economic, and industrial development, and foreign and domestic commerce, as well as the availability of alternatives to ocean disposal. EPA has a major environmental oversight role in reviewing the USACE determination of compliance with the ocean-disposal Criteria relating to the effects of the proposed disposal. If EPA determines ocean-disposal Criteria are not met, disposal may not occur without a waiver of the Criteria by EPA [40 CFR 225.2 (e)]. Dredged material from Pearl Harbor suitable for ocean disposal may be disposed at the EPA-designated South Oahu Disposal Site. EPA, additionally, has authority under Section 102 to designate ocean-disposal sites. The USACE is required to use such sites for ocean disposal to the extent feasible. Section 103 does authorize the USACE, where use of an EPA-designated site is not feasible or a site has not been designated by EPA, to select ocean-disposal sites for project(s)-specific use. In exercising this authority, the USACE utilizes the EPA site-selection criteria (40 CFR 228), and the site selection is subject to EPA review as part of its permit review responsibilities.

Overview of CWA

Section 404 of the CWA requires EPA, in conjunction with the USACE, to promulgate "Guidelines" for the discharge of dredged or fill material to ensure that such proposed discharge will not result in unacceptable adverse environmental impacts to waters of the United States. Section 404 assigns to the USACE the responsibility for authorizing all such proposed discharges and requires application of the Guidelines in assessing the environmental acceptability of the proposed action. Under the Guidelines, the USACE is also required to examine practicable alternatives to the proposed discharge, including alternatives to disposal in waters of the United States and alternatives with potentially less damaging consequences. The USACE and EPA also have authority under Section 230.80 to identify, in advance, sites that are either suitable or unsuitable for the discharge of dredged or fill material in waters of the United States. EPA is responsible for general environmental oversight under Section 404 and, pursuant to Section 404(c), retains permit veto authority. In addition, Section 401 provides the States a certification role as to project compliance with applicable State water quality standards. Disposal of dredged material within Pearl Harbor will require authorization under Section

404 of the CWA and will require a Section 401 Water Quality Certification from the State of Hawaii.

Overview of NEPA

Dredged material disposal activities must comply with the applicable NEPA requirements regarding identification and evaluation of alternatives. The basic NEPA process discussed in this framework is that specifically associated with the dredging project (as opposed to other related actions such as ocean-site designation which may require an entirely separate NEPA process).

Section 102(2) of NEPA requires the examination of reasonable alternatives, both technically and economically, to the action proposed by the lead agency. The alternatives analyzed in an Environmental Assessment (EA) or Environmental Impact Statement (EIS) must include not only all reasonable alternatives but also those that were eliminated from further study (Part 1502.14) by the agency responsible for the final decision. The NEPA document must rigorously address reasonable alternatives that are beyond the capability of the applicant or project proponent or are beyond the jurisdiction of the lead agency. The Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA are found at 40 CFR 1500-1508.

State Water Quality Certification

Section 401 of the CWA provides the States a certification role as to project compliance with applicable State water quality standards. Water quality certification usually focuses on meeting applicable state water quality standards that have been approved by EPA. Unless waived on a case-by-case basis by the State or on such occasions overridden by critical factors in the national interest, State 401 Water Quality Certification must be obtained prior to initiation of any Federal or non-Federal dredged material disposal activity which occurs within navigable waters of the United States (40 CFR 230.10(b)(l)). A Section 401 Water Quality Certification from the State of Hawaii will be needed for disposal of dredged material within Pearl Harbor.

Coastal Zone Consistency

The Coastal Zone Management Act requires USACE to coordinate permit review and Federal projects with all State level coastal zone review agencies. Under this act, coastal States are required to formulate a management program for the land and water resources of its coastal zone, which extends out to the seaward limit of the territorial sea, and submit it for approval to the Secretary of

Commerce. After final approval by the Secretary of Commerce of a State's management program, any applicant for a Federal permit must have certification that the proposed disposal complies with the State's approved program.

Solid Waste/RCRA Considerations

The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid waste, not dredged material. For environmental and economic reasons placement of dredged material in upland environments is a widely held practice at many navigation projects. Upland placement of dredged material is characterized using the CWA Section 404(b)(1) guidelines developed by EPA, in conjunction with the USACE, the NEPA, and Section 10 of the Rivers and Harbor Act (RHA). The 404(b)(1) guidelines require thorough evaluation of the potential contaminant pathways from the dredged material placement operation. A dredged material discharge is defined at 33 CFR323.2 (c) as: "... any addition of dredged material into the waters of the United States. The term includes, without limitation, the addition of dredged material to a specified discharge site located in waters of the United States and the runoff or overflow from a contained land or water disposal area."

For example, if dredged material is placed in a CDF or at a temporary holding facility where there is a discharge of water for purposes of drainage or dewatering, the activity would be regulated under the CWA. Dredged material transported from a rehandling facility or directly from a dredging operation and placed at an upland site or in a licensed solid waste landfill with no discharge to waters of the United States, also would not be evaluated under the RCRA since the dredging operation itself would require a Section 10 RHA permit. The Section 10 permit provides ample authority to evaluate the potential contaminant pathways at upland sites where there is no discharge into waters of the United States. While not regulated under RCRA, the testing and evaluation used in these instances would generally satisfy RCRA guidelines. Material removed in a dewatered condition from a CDF and subsequently placed at an upland site without a discharge to waters of the United States would require evaluation to determine the material's hazardous characteristics under RCRA guidelines. This would be required even when the material is not to be placed in a RCRA-permitted facility.

EPA is currently proposing changes to the regulations which would exclude disposal of dredged material with discharges in waters of the United States or in ocean waters, and permitted under the CWA or MPRSA, from regulation as a hazardous waste, Section 262.4(h) of RCRA.

CERCLA Considerations

Pearl Harbor is listed as a Superfund site on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List. The present position of EPA Region IX is that the CERCLA materials are the result of past activities which could have an adverse effect on human health and the environment within the harbor, and that dredging of sediments for navigation is based strictly on operational requirements, and thus not subject to CERCLA.

However if sediments to be dredged are determined by the EPA to be CERCLA materials, regulatory jurisdiction falls to the EPA under CERCLA. Any associated dredging activity related to the materials also falls under CERCLA and such an activity is no longer dredging for navigation. However, nothing precludes the USACE, EPA, or the Navy from using the evaluative protocols of the CWA or MPRSA to characterize and manage the material.

The USACE does not issue permits for CERCLA materials, but the USACE must ensure that the material is environmentally acceptable if a CWA or MPRSA site is chosen for disposal. Therefore, the same testing and evaluation procedures as given in the joint USACE/EPA Technical Framework (USACE/EPA 1992) would be applied as appropriate. Essentially, the 404/103 protocols could be used to evaluate the material and to select a management option that is not less environmentally protective than one that would be selected under the CWA or MPRSA. Since CERCLA supersedes all other regulatory jurisdiction of other statutes, neither CWA Section 404 or MPRSA Section 103 permits would be required. Under this scenario, the EPA would have total regulatory control.

Overview of Section 10 of the Rivers and Harbor Act

Section 10 of the Rivers and Harbor Act requires a permit from the USACE for structures or work affecting navigable waters of the United States. Dredging and disposal of dredged material within Pearl Harbor will require authorization from the USACE under Section 10 of the RHA. Acquisition of this permit is routine and can be readily obtained.

Long-Term Management Strategy (LTMS) Approach

Definition of LTMS

Locating suitable sites for the long-term management of dredged material is a major problem for navigation projects (U.S. Congress, Office of Technology Assessment 1987). Many dredging projects, and in some cases, the project beneficiaries, routinely rely on cycle-to-cycle location of disposal sites. This approach often results in significant project delays and recurring needs to invoke emergency dredging procedures for nationally sensitive navigation projects.

In 1978, the U.S. Army Corps of Engineers (USACE) Dredged Material Research Program concluded that long-term dredged material management plans would offer greater potential for providing required environmental protection at reduced project costs and would meet with greater public acceptance once they are adopted and implemented (Saucier et al. 1978). More recently, a number of prominent scientific and engineering groups have strongly recommended that the USACE develop the concept of a Long-Term Management Strategy (LTMS) for navigation projects (Klesch 1987). The approach being used in development of the LTMS for NAVSTA, Pearl Harbor, is generally based on the USACE nationwide approach to LTMS development (Francingues and Mathis 1989) and is described in the following paragraphs.

The purpose of an LTMS is to provide a consistent, logical procedure by which alternatives can be identified, evaluated, screened, and recommended so that the dredged material placement operations are conducted in a timely and cost-effective manner. A workable LTMS for Pearl Harbor should meet the following criteria:

a. Normally a 50-year time horizon should be the established target or goal, while recognizing that project-specific circumstances may, in certain projects, dictate a shorter time frame. In this study, a 30-year time horizon was set because the LTMS is only for unsuitable material and the quantity of unsuitable material would be expected to decrease significantly as the existing unsuitable sediments are dredged and sources of contaminants are eliminated during this period.

b. LTMS development must include all foreseeable new work and maintenance activities.

c. Unless specifically prohibited by statute, LTMS development must incorporate the full and equal consideration of all dredging and dredged material management alternatives. No one management option can be considered a panacea for dredged material nor can it be ruled out in the initial plan formulation process for reasons other than sound economic, environmental, and engineering considerations.

d. LTMS development must be timely, technically feasible, cost-effective, and environmentally acceptable as dictated by established standards, criteria, and regulations.

Conceptual Process for LTMS Development

The conceptual process for LTMS development is an orderly, sequential process which:

a. identifies project needs and performs a preliminary assessment of these dredging needs versus the existing/available site capacity;

b. formulates alternatives, where necessary, to offset project shortfalls;

c. applies detailed screening procedures based on engineering, economic, and environmental considerations to arrive at a preferred alternative;

d. develops procedural, administrative, and management plans for LTMS implementation; and

e. provides for periodic review and updating of the LTMS plan to maintain viable long-term project operations.

The tasks to accomplish the first three items listed above are designated Phases I, II, and III and are presented in the following sections.

Phase I - Formulation of Preferred Disposal and Management Alternatives

Tasks associated with Phase I are summarized below.

a. Gather and review existing data on dredging equipment including mechanical dewatering (if appropriate), capabilities, and requirements (volumes, shoaling rate, sediment physical characteristic, etc.). Data should also include information on water and sediment quality.

b. Estimate capacities of the proposed alternatives.

c. Compare future dredging/disposal needs with potential existing disposal site capacities and establish shortfalls, including consideration of mechanical dewatering by hydrocyclones, belt filter presses, vacuum filtration, and pressure filtration.

d. Gather and review available data/information on physical and contaminant characteristics at dredging and potential disposal sites.

e. Identify data gaps and relate these data to anticipated dredging and disposal equipment to identify potential environmental effects of a dredging operation.

f. Gather and review data/information on existing environmental resources at dredging and potential disposal sites. Determine temporal and seasonal relation of resource to study area.

g. Identify special technical or environmental problems to be considered during the dredging or disposal operations. Review existing reports and data on endangered species and benthic invertebrates, and identify concerns and positions of resource and regulatory agencies.

h. Identify alternative dredging techniques and disposal options that meet the LTMS study objectives. Those options should be prioritized according to projected disposal requirements (volumes, water quality, hydraulic and sediment transport, and other areas of interest relative to selection of dredging methods), transportation systems, and disposal options. Prioritize the needs based on value to project and costs.

i. Develop environmental, engineering, and economic criteria for dredging and disposal based on results of Phase I data review and testing, incorporating substantiated concerns of resource agencies and local interests into the environmental criteria. The environmental criteria should include issues such as spatial and temporal proximity to ecologically sensitive areas and endangered species. The engineering criteria should be based on physical limitations of dredging equipment (pumping or haul distances, etc.) and should address physical impacts and contaminant transport potential, etc.

j. Identify potential beneficial uses for dredged material.

k. Refine study objectives and boundaries (spatial/temporal) for the LTMS.

l. Define management options.

m. Summarize findings and conclusions of Phase I and recommendations for Phase II. The report will include a description of each alternative and a summary of the advantages and disadvantages of each. The descriptions will contain the location, capacity, proposed operation and management, testing requirements to satisfy regulations, dredging and disposal cost estimates, potential mitigation costs, potential environmental impacts and restrictions, and other considerations.

Results of Phase I for this LTMS are documented in this report.

Phase II - Evaluation of Alternatives

Activities associated with the evaluation of appropriate LTMS alternatives are listed next. (Details for types and scopes of specific engineering and environmental studies are presented below in the section on testing requirements, based upon the preliminary findings of Phase I outlined above. The following tasks are envisioned as necessary to complete Phase II, but may require some modifications.)

a. Perform appropriate environmental and engineering studies necessary to evaluate the preferred, viable dredging and disposal alternative(s) (outlined below in Table 1 for all alternatives examined and in Table 8 for the alternatives recommended in this report). The evaluation procedures are listed in Table 1 by pathway, test or task, along with their time and funding requirements. Lab tests would not be repeated for multiple alternatives, but analysis and screening procedures would have to be repeated due to differences in management and operating conditions.

b. Obtain additional data on sediment and water samples and assess characteristics and disposal needs, more cultural/historic resources related to dredged material physical properties for evaluation of range of dredging induced environmental alternatives, beneficial uses, or other options. Conduct site studies for hydraulic analyses, upland, surface and groundwater evaluations, and environmental impact of dredged material disposal. Testing requirements for dredged material evaluation should be consistent with the CE's Regulatory Guidance Letter dated 19 August 1987. (U.S. Army Corps of Engineers Regulatory Guidance Letter, subject: Testing Requirements for Dredged Material Evaluations, dated 19 August 1987 and signed by BG Peter Offringa, Deputy Director of Civil Works.)

Phase III - Analysis of Alternatives and Selection of an LTMS

Specific tasks to be conducted as part of Phase III activities should include but may not be limited to the following tasks.

a. Analyze the Phase II evaluation findings and develop alternative LTMS's by combining appropriate dredging and disposal management options.

b. Prepare and report preliminary design of disposal alternative, required restrictions and controls, operational/handling requirements, and management actions of the viable alternative established in Phase II.

TABLE 1. TESTING REQUIREMENTS

Test	Method	Disposal Alternative	Duration	Cost
Effluent	Flocculent settling test and modified elutriate test.	Upland, Nearshore	2 months	$20K
Runoff	Simplified runoff extraction test.	Upland, Nearshore	3 months	$40K
Leachate	HELPQ and RAAS screening model predictions.	Upland, Nearshore	1 month	$15K
Volatilization	Thibodeaux screening model predictions.	Upland, Nearshore	1 month	$15K
Plant Uptake	DPTA extract test.	Upland, Nearshore	1 month	$10K
Plant Growth	Greenhouse plant growth, toxicity, and bioaccumulation testing.	Upland, Nearshore	4 months	$60K
Animal Uptake	Earthworm bioassay test.	Upland, Nearshore	4 months	$65K
Water Column	Standard elutriate test and water column bioassay.	Contained Aquatic Disposal (CAD)	1 month	$12K
Cap Diffusion	RECOVERY model predictions.	CAD	1 month	$15K
Sedimentation	Zone and compression settling tests.	All	1 month	$10K
Sediment Characterization	Atterberg limits, specific gravity, grain-size distribution, organic content, in situ moisture content, and bulk chemistry.	All	1 month	$15K
Consolidation	Self-weight and standard oedometer consolidation tests.	Upland, Nearshore	2 months	$15K
Sediment Characterization and Consolidation of Cap Material	Atterberg limits, specific gravity, grain-size distribution, organic content, in situ moisture content, bulk chemistry, and self-weight and standard oedometer consolidation tests of capping material.	CAD	2 months	$25K
TCLP	EPA method for toxicity characteristics leaching procedure.	Upland Reuse	1 month	$10K
Odor	Odor screening and control testing.	Upland, Nearshore	2 months	$15K
Soil Amendments	Soil screening tests.	Beneficial Use	6 months	$85K

c. After initial screening of alternatives, hold coordination meetings with appropriate public and private interest groups to solicit input on study recommendations.

d. Retain best alternatives and gain concurrence from interested parties.

e. Report recommended LTMS and recommendations for implementation. The report should contain a description of the recommended alternative(s), based on environmental, engineering, and economic findings and a long-range implementation schedule. The report should also include documentation of any public notices, Memorandum of Agreements (MOA's), and other relevant documents (Section 404, Coastal Zone Management, Historic Preservation) related to site access, site acquisition, material reuse, or other aspect of the LTMS. The appropriate environmental and engineering studies should be referenced in the LTMS, but not included in the LTMS report.

f. Acquisition of the NEPA and 404 Clearances that would be needed to implement the LTMS should also be conducted concurrently with preparation of the LTMS documentation. Since much of the NEPA and 404 work would already be completed during the LTMS study (i.e., acquisition of environmental data, agency and public coordination, etc.), it should not require that much additional effort to prepare required documents and get required clearances. This would make the LTMS a complete package ready for Navy review and approval.

3 - Project Description and Dredging Requirements

This chapter summarizes the characteristics of the Naval Facilities at the Pearl Harbor Naval Complex (PHNC), as they pertain to dredging and dredged material disposal, and provides a description of the dredging equipment and techniques which have been used for Pearl Harbor. Dredged volumes and physical and chemical characteristics of the materials dredged are also described. The future dredging requirements for the projects are estimated from past dredging histories.

Description of Naval Facilities

The PHNC has been developed since the turn of the century within a natural estuary on the south coast of the island of Oahu. A detailed description of facilities and activities was prepared for the Pearl Harbor Sediment Study conducted by Ogden Environmental (1996) for the PACNAVFACENGCOM and is presented in Appendix A of this report for purposes of completeness.

Over the years, the navigation channels, turning basins, and berthing areas have been expanded and deepened. Also, dredged material from the harbor has been used for fill to create some of the shoreline facilities. Currently, the navigation facilities for PHNC consist of an entrance channel, a main navigation channel extending around Ford Island, and a number of operational areas serving specific Naval activities. The major activities include the Naval Station, Pearl Harbor (NAVSTA); Fleet and Industrial Supply Center, Pearl Harbor (FISC); Naval Shipyard, Pearl Harbor (NAVSHIPYD); Navy Public Works Center, Pearl Harbor (PWC); and the Naval Magazine, Pearl Harbor (NAVMAG). Pertinent descriptions of each of these activities are given in Appendix A. The most active reaches of the main navigation channel are located on the east side of Ford Island between the island and NAVSTA. The entrance channel is maintained to a depth of 50 ft, and the main navigation channels are maintained to depths of 40 to 50 ft. The maintained depth of the projects varies from 35 to 50 ft.

Project Setting and Environmental Resources

The PHNC lies within an estuary which has undergone many changes as a result of development. The estuary receives drainage from the southern portion of Oahu, and the drainage basin has undergone great changes in the last few decades. Descriptions of the upland, wetland, and marine environments in the area, topography, geology, soil characteristics, surface water, groundwater, climatology, and land use are given in Appendix A.

Sediments within the PHNC contain a variety of contaminants. Potential types of sources for the contaminants including those originating in the harbor itself have recently been identified (Ogden Environmental 1996). Industrial and operational activities of the Navy, private industry, municipal, commercial, urban, and agricultural sources have contributed a wide variety of contaminants to the harbor including metals, pesticides, hydrophobic organics (such as PCBs and PAHs), petroleum, oil, lubricants, solvents, etc. Ogden Environmental (1996) contains detailed information on contaminant sources. Ogden Environmental (1996) concluded that, although contaminants are present in the sediments, the concentrations are generally low as compared to other major harbors in the United States.

The harbor area is generally characterized by high biological complexity and productivity, and the estuary is an important nursery area for many marine species. Wetland areas located adjacent to the harbor are known habitats for several endemic and endangered waterbird species. These areas include the Pearl Harbor National Wildlife Refuge, which is managed under a cooperative agreement among the Navy and Federal and state resource agencies. Descriptions of specific habitats and species are given in Ogden Environmental (1996).

Material Characteristics

This section describes the characteristics of the dredged material at Pearl Harbor. Information on the material characteristics was obtained from dredging records and included physical characteristics, sediment chemical inventories, and biological testing results.

Sediments from within the harbor are sampled in conjunction with various permit applications and construction design documents. These data are focused on only a few areas within the harbor and do not give a comprehensive picture of the nature of the sediments harbor-wide. A more comprehensive study of sediment characteristics was performed by the USACE Honolulu District (CEPOH) in 1990 (USACEPOD 1990a and 1990b). This study included grain-size distribution, sediment chemical inventories, and bioassays on 12 composite sediment samples from throughout the harbor. No Atterberg liquid limit data or in situ water content data for these composites are available.

Sediment Physical Characteristics

Physical data such as grain-size distribution, Atterberg limits, and Unified Soil Classification System (USCS) classification are very limited. The available data throughout the harbor indicate that both sands and silts are dredged. The sediments which are unsuitable for ocean disposal are likely to be silts. Because of their volcanic origin, these silts may be more permeable and therefore more easily drained and dewatered than silts from other areas. Representative data obtained from the areas near the S4/S5 and S8/S9 docks and the Ford Island Bridge are given in Table 2. Geotechnical data were collected from 9 borings taken in 1994 by Harding Lawson Associates in the area to be dredged for P-097 Submarine Berthing Pier project. The data consisted primarily of a description, dry bulk density, and moisture content. Limited data on the engineering properties (e.g. Atterberg limits) were taken in 1994 by Parsons Brinckerhoff for the Ford Island Bridge project which should be representative of dredged material and foundation sediments.

TABLE 2. GEOTECHNICAL DATA

Property	Submarine Berthing Pier	Ford Island Bridge
Liquid limit of foundation sediments	88	
Liquid limit of surficial sediments	71	
Plasticity index of foundation sediments	41	
Plasticity index of surficial sediments	28	
Dry bulk density of foundation sediments (pcf)	52	58
Dry bulk density of surficial sediments (pcf)	44	51
Moisture content of foundation sediments (%)	75	70
Moisture content of surficial sediments (%)	89	81

A summary, representing the average or typical value of all borings in the vicinity of P-O97 Berthing Pier and at the Ford Island Bridge, is given in Table 2. The data showed only minor differences between the two sites. The geotechnical characteristics ranged from a very soft, saturated, gray sandy plastic silt (lagoonal deposits) to a loose, saturated, fine-grained sand and gray silty gravel with sand (lagoonal deposits). Each sediment boring was divided into two sections, one taken at less than 40-ft depths (surficial harbor sediments) and the other at greater than 40-ft depths (consolidated alluvium foundation). The sediment data for materials at depths less than 40 ft were assumed to be representative of the materials to be dredged and consisted of materials classified as MH (silt of high compressibility) and ML (silt of low compressibility) under the USCS.

Sediment Chemical Inventory

The volume of sediment chemical concentration data is substantial and is only summarized here. Representative mean and maximum contaminant concentrations recently measured in sediment from operational areas are summarized in Table 3. The mean, lowest, and highest bulk sediment concentrations of 12 composite samples collected throughout the waters of Pearl Harbor in 1990 are summarized for selected chemical parameters in Table 4.

Biological Testing

A major consideration for this LTMS is the proportion of sediments to be dredged which are unsuitable for ocean disposal. This determination must be made using various assessments in accordance with the Testing Manual for Evaluation of Dredged Material Proposed for Ocean Disposal (USEPA/USACE 1991). Toxicity tests and bioaccumulation tests are normally required.

Biological tests were conducted on the 12 composite samples taken in 1990. These tests included 96-hour suspended phase bioassays with *Pennaeus vannamei* and *Artemia salina*, 10-day solid phase bioassays with *Mercenaria mercenaria* and *Pennaeus vannamei*, and bioaccumulation tests using shrimp *Pennaeus vannamei* and *Mercenaria mercenaria*. The tests yielded insignificant toxicity and limited bioaccumulation of consequence.

In response to designation of the PHNC as a Superfund site, the NAVSTA has recently conducted an extensive surficial (top 2-cm) sediment testing program for the PHNC (part of an RI study), to include biological tests for sediments throughout the harbor area. Toxicity tests using the amphipod *Amelisca Abdita* and fertilization tests using echinoderm *Dendraster excentricus* were conducted. The results of the sediment testing are yet to be published; however, summary results of these tests are shown in Figures 2 and 3.

Dredging Requirements

Dredging at Pearl Harbor is required to maintain navigable depths. Historically, material was dredged from the main channels by hopper dredge. The USACE hopper dredge *Essayons* is normally used for the main channels once every 6 to 9 years. The work at PHNC is normally accomplished when the dredge maintains the Federal navigation channels in Hawaii. In the past these sediments had been disposed at the ocean disposal site.

TABLE 3. SEDIMENT CHEMISTRY FROM OPERATIONAL AREAS

Contaminants	Bulk Sediment Chemistry, mg/kg Dry Weight					Guideline Values	
	Piers S4-S5, S8-S9		Wharf Y-2	Wharves B22-B26, M1-M4 and Hawala Stream Mouth			
	Mean	Max	Mean	Mean	Max	ER-L	ER-M
Arsenic	12.8	15.5	9.9	7.1	15	1.0	3.7
Cadmium	BD	BD	0.35	0.65	1.0	8.2	70
Chromium	106	125	102	231	359	1.2	9.6
Copper	210	379	180	272	435	34	270
Lead	209	540	49.3	191	509	46.7	218
Mercury	1.13	1.79	0.47	0.86	2.42	0.15	0.71
Nickel	65.8	77.7	64.9	170	218	20.9	51.6
Silver	1.54	2.1	1.0				
Zinc	301	473	211	312	505	150	410
Ammonia	53.6	58	46.8	158	290		
Cyanide	BD	BD	BD	BD	BD		
Sulfide	5.0	10.1	99.9	567	1500		
TOC	34,600	48,000	29,000	13,000	14,000		
Total Solids, %	46.4	48.4	48.4	44	46		
TPH	3840	7700	1600				
Organotins	0.00804	0.03632	BD	0.027	0.044		
Chlorinated Phenols	BD	BD	BD	BD	BD		
Pthalates	1.07	3.6	BD	0.7	1.3		
PAHs	17.4	51.5	2.4	6.37	14.66	4.022	44.792
ΣDDT	0.0169	0.0266	BD	0.0336	0.0943	0.002	0.015
Endrin	0.007	0.015	BD	BD	BD		
Endrin Ketone	0.015	0.036	BD	BD	BD		
Total PCBs	0.48	0.76	0.58	0.308	0.740	2.7	180

BD = Below Detection

TABLE 4. SEDIMENT CHEMISTRY OF 12 PEARL HARBOR COMPOSITES

Contaminants	Mean, mg/kg dry	Lowest, mg/kg dry	Highest, mg/kg dry
Arsenic	0.285	0.016	0.91
Cadmium	0.8	0.3	1.5
Chromium	23.3	7.4	35.5
Copper	27.1	3.7	79.4
Lead	31.1	8.6	55.3
Mercury	0.19	0.082	0.49
Nickel	28.0	6.7	39.2
Silver	1.6	0.4	3.7
Zinc	65.2	23.8	107.3
Cyanide	BD	BD	BD
Sulfide	31.0	2.6	120
TOC	11,500	7,200	17,000
Petroleum Hydrocarbons	255	<50	1,100
Organotins	0.066	0.021	0.356
Total Phenols	BD	BD	BD
Pthalates	BD	BD	BD
PAHs	BD	BD	BD
Pesticides	BD	BD	BD
PCB-1260	0.28	<0.15	0.90
DDE	BD	BD	BD
DDD	BD	BD	BD
DDT	BD	BD	BD

BD = Below Detection

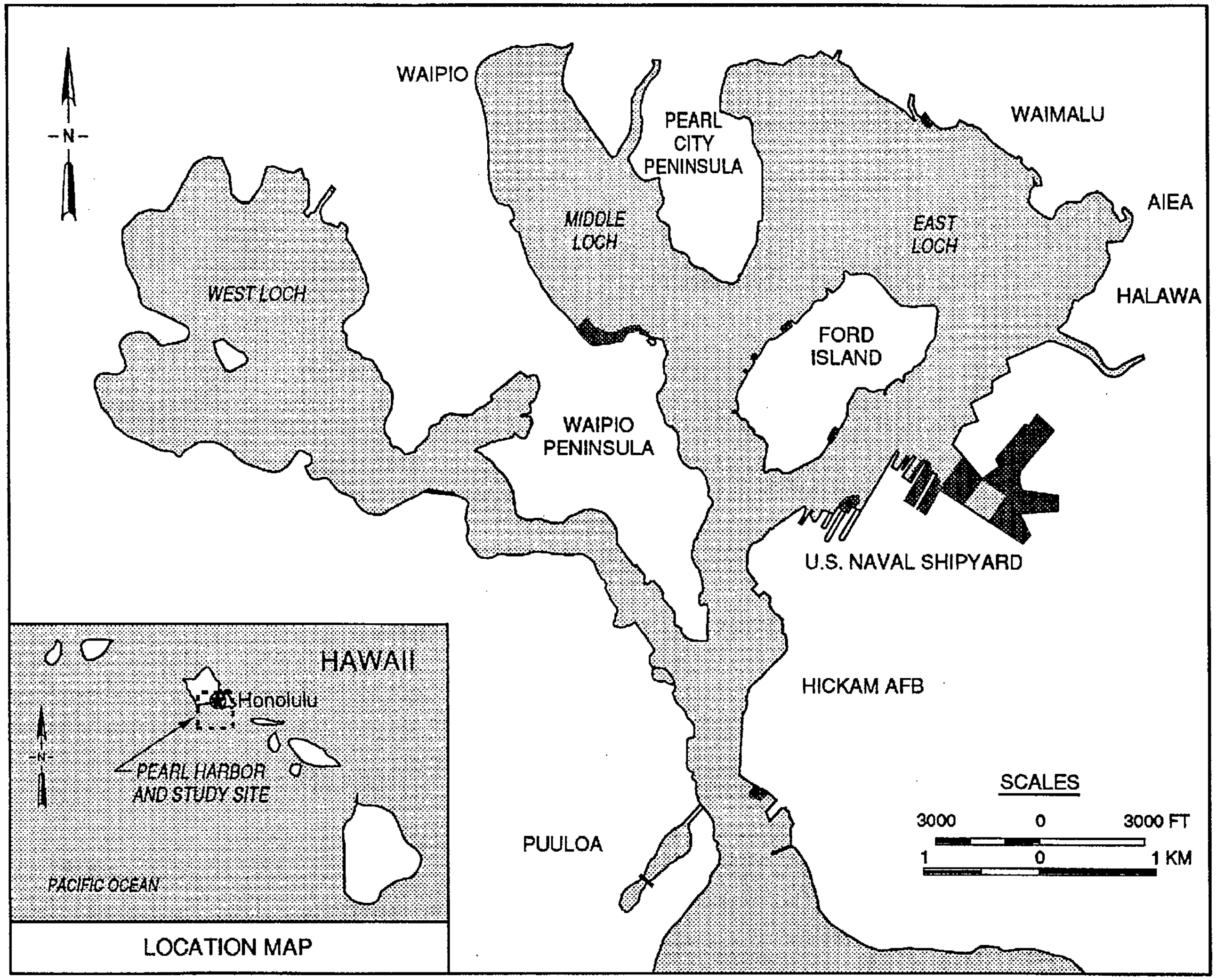

Figure 2. Areas exhibiting greater than 20% amphipod mortality

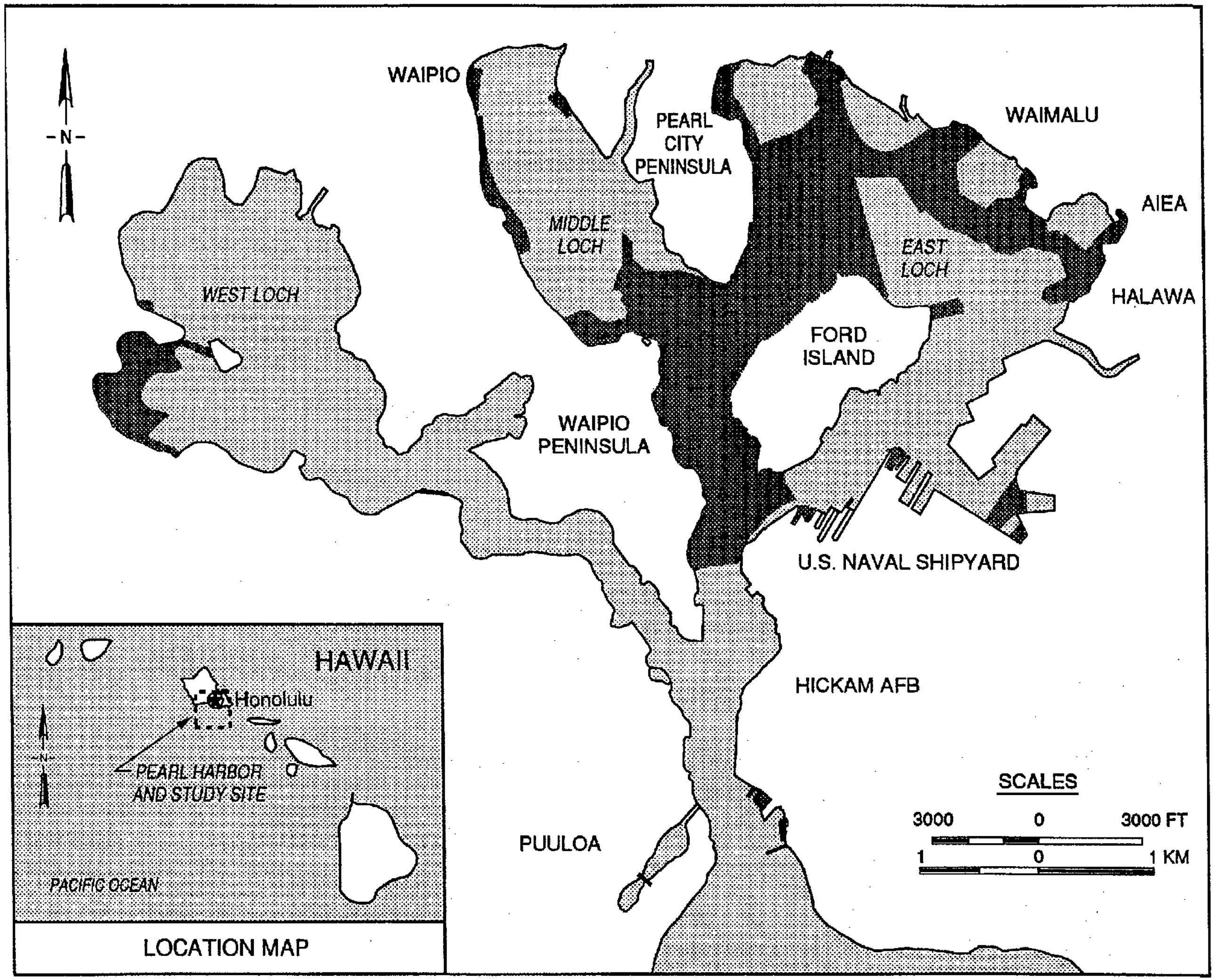

Figure 3. Areas exhibiting greater than 20% reduction in echinoderm fertilization

The berthing areas and other project areas are too constricted for use of a hopper dredge. These project areas have been historically dredged by clamshell, with material transported by barge to the ocean disposal site. Use of CDFs in the future for materials unsuitable for ocean disposal would require alternate dredged-material-handling approaches. Possible alternate approaches are discussed in Chapter 4.

Information on previous dredging and disposal operations for Pearl Harbor was obtained from available dredging records. These records included environmental impact statements, before and after dredging surveys, public notices, correspondence between interested parties, and a summary of dredging contracts administered by the Navy. No extensive investigation of shoaling rates has been conducted at any of the projects; therefore, a determination of dredging requirements must be based on a history of past dredging operations. However, it is difficult to determine the future dredging requirements from the dredging records due to the fact that the main navigation channels have only been dredged a few times and the time interval between dredging projects has been inconsistent. Dredging in the operations areas is very infrequent; most of the operation areas have never been dredged or have been dredged only once. Further, the shoaling rates are unpredictable and small. Determining future dredging requirements has been further complicated by the fact that new work dredging contracts were necessary at some locations before any maintenance dredging contracts were undertaken. A summary of the dredging history is given in Table 5, and a summary of ocean disposal from Pearl Harbor is given in Table 6. The data from past projects are insufficient to make a definitive determination of the dredging volume and frequency for the main channel or for project requirements along the piers and wharfs. Consequently, an estimate of future requirements for unsuitable dredged material for ocean disposal is based on the on-going RI study being done by Ogden.

The NAVSTA has also recently developed a dredge plan for Pearl Harbor with anticipated dredging volumes for the next few years. This dredging plan is given in Table 7. Approximately 500,000 to 1,000,000 cu yd are dredged from the main channels by the Corps' hopper dredge *Essayons* once every 6 to 9 years when the dredge clears the Federal channels in Hawaii. The remainder of the volume of required dredging is from a number of small projects (7,000 to 100,000 cu yd) within the berths and along the piers and wharfs. These projects are planned for execution within five years.

Since 1971 portions of eleven dredging projects have been conducted in operational areas which would be considered presently to contain sediment unsuitable for ocean disposal (greater than 20% mortality in the amphipod bioassay test) on the surface based on the findings of the RI study. These eleven projects totalled approximately 280,000 cu yd. (At the time that the projects were conducted, none of these eleven projects were actually

TABLE 5. PAST DREDGING PERMITS FOR PEARL HARBOR

Permit No.	Date	Applicant	Project
58	1931	Hawaiian Dredging Co.	1,800,000 cu yd of dredged material from Pearl Harbor dumped into Mamala Bay
75	1933	Hawaiian Dredging Co.	275,000 cu yd of dredged material from Pearl Harbor dumped into Mamala Bay
79	1933	Hawaiian Dredging Co.	700,000 cu yd of dredged material from Pearl Harbor dumped into Mamala Bay
83	1934	Hawaiian Dredging Co.	4,500,000 cu yd of dredged material from Pearl Harbor dumped into Mamala Bay
103.5	1936	Hawaiian Dredging Co.	2,500,000 cu yd of dredged material from Pearl Harbor dumped into Mamala Bay
797-D	1966	Dept. of Navy	Dredging 1,000,000 cu yd of coral from reef off Fort Kamehameha
952-D	1971	Navy PWC	Maintenance dredging at Dry Dock #4
964-D	1971	PACDIV	Pearl Harbor SUBASE dredging and widening, lengthening and demolition of existing piers
966-D	1971	Navy PWC	Maintenance dredging in Pearl Harbor
985-D	1971	PACDIV	Dredge Wharf W-22
1005-D	1972	Navy PWC	Dredge 35,000 cu yd at Pearl Harbor Naval Shipyard
1043-D	1972	Navy OICC, MIDPAC	Dredge, repair all fender piles. Dredging of 12,700 cu yd not done; valid until Dec 1975.
1068-D	1973	Navy PWC	Maintenance dredging Dry Docks 1, 2, and 3 and Marine Railway #2
1257-D	9/76	Navy OICC, MIDPAC	Construct extension to berthing dock AFDM (P-051) dredge approx. 85,000 cu yd
1268-D	9/76		Dredging Naval Supply Center berthing
1274-D	2/77		Maintenance dredging
1418-D	2/77	HECO	Dredging cooling water intake basins Waiau
1657-D	6/82		Magazine Loch
1751-D	11/83		Maintenance dredging of Pearl Harbor

TABLE 6. HISTORICAL USE OF OCEAN DUMP SITES IN HAWAII BY THE U.S. NAVY

Permit Number	Month	Year	Permittee	Type of Work	Location	Volume, cu yd	Ocean Disposal Site
		1968	Corps Dredge	Maintenance	Pearl Harbor	2,611,754	Honolulu
966*	Jun	1971	US Navy	Maintenance	Pearl Harbor, Subdock	10,000	Honolulu
985	Aug	1971	US Navy	Maintenance	Pearl Harbor W-22	7,000	Honolulu
		1972	Corps Dredge	Maintenance	Pearl Harbor	53,000	Honolulu
1005*	Jun	1972	US Navy	Maintenance	Pearl Harbor Shipyard	35,000	Honolulu
1005-MOD*	Dec	1972	US Navy	Maintenance	Pearl Harbor Shipyard	2,500	Honolulu
1068*	Dec	1973	US Navy	Maintenance	Pearl Harbor, Drydock/Mrail	17,000	Honolulu
1068-MOD*	Apr	1975	US Navy	Maintenance	Pearl Harbor, Drydock/Mrail	3,000	Honolulu
1268*	Sep	1976	US Navy	Maintenance	Pearl Harbor, NSC	78,000	Honolulu
		1977	Corps Dredge	Maintenance	Pearl Harbor	761,354	Honolulu
1274		1978	US Navy	Maintenance	Pearl Harbor, Docks and Chan	1,155,400	Honolulu
1657*	Jun	1982	US Navy	Maintenance	Pearl Harbor, Mag Loch	55,700	Honolulu
1274-MOD	Dec	1982	US Navy	Maintenance	Pearl Harbor	10,000	Honolulu
1751		1984	US Navy	Maintenance	Pearl Harbor Hopper/Docks	2,469,000	Honolulu
1751-MOD*	Mar	1985	US Navy	Maintenance	Pearl Harbor SUBASE	12,000	Honolulu
GP-84-2-A**	Jul	1986	US Navy	Maintenance	Middle Loch, Pearl Harbor	186,000	Honolulu
GP-84-2-B*	Mar	1989	US Navy	Maintenance	Magazine Loch, Pearl Harbor	11,000	Honolulu
GP-84-2-D	Mar	1990	US Navy/Corps Dredge	Maintenance	Pearl Harbor- Whole	600,000	Honolulu
GP-84-2-C**	May	1990	US Navy	Maintenance	Pearl Harbor- Middle Loch P186	9,000	S. Oahu
GP-84-2-E	Jul	1990	US Navy	Maintenance	Pearl Harbor- Fox 5	360,000	S. Oahu
GP-84-2-F**	Mar	1991	US Navy	Maintenance	Pearl Harbor- Middle Loch	84,500	S. Oahu
GP-84-2-G	Jul	1991	US Navy	Maintenance	Pearl Harbor- Wharf W-5	50	S. Oahu
GP-84-2-H*	Dec	1991	US Navy	New Work	PH-Wharfs Y3A, P120, Y3B	50,000	S. Oahu
GP-84-2-1	Feb	1992	US Navy	New Work	Pearl Harbor- Wharf K12	3,000	S. Oahu

* Potentially unsuitable for ocean disposal.

** Partially marginally unsuitable for ocean disposal.

TABLE 7. PEARL HARBOR NAVAL STATION DREDGE PLAN

PRIORITY	LOCATION	VOLUME, cu yd	FY
1*	Bravo 22-26	10,350	00
2*	Mike 1-4	31,000	Unprogrammed
3**	Main Channel	350,000	Unprogrammed
4	Ferry Channel	85,000	Unprogrammed
5	Hotel 1-4, Kilo 10-11, Halawa Mouth	57,000	Unprogrammed
6	Halawa Stream	19,500	Unprogrammed
7	Alfa 1-7	7,960	Unprogrammed
8*	Shipyard	153,400	Unprogrammed
9*	SUBASE	135,300	Unprogrammed
10	Landing "C"	7,000	Unprogrammed
11**	Middle Loch	453,000	Unprogrammed
12*	Fox 9-10	40,000	Unprogrammed

* Potentially unsuitable for ocean disposal.
** Partially marginally unsuitable for ocean disposal.

determined to be unsuitable for ocean disposal following the guidelines and testing protocols existing at the time of the projects. Testing requirements and guidance were revised in 1991 and the use of project-wide sediment composites was also eliminated in 1993.) Five additional dredging projects in operational areas potentially containing sediments unsuitable for ocean disposal (based on RI study findings) are planned for conduct in the next five years, totaling approximately 370,000 cu yd. In addition, three dredging projects in Middle Loch were conducted during this period in areas which surficial sediments presently show a questionable level of contamination based on the RI study (less than 20% mortality in the amphipod bioassay test but having greater than a 20% reduction in echinoderm fertilization). Use of echinoderm fertilization is presently unreliable as a measure of suitability for ocean disposal, but the results are given here only to determine an upper bound for the estimate of potentially unsuitable material for ocean disposal. These three projects totaled approximately 280,000 cu yd. One additional dredging project in the Middle Loch, approximately 450,000 cu yd, is planned for conduct in the next five years. Additional dredging projects have been conducted in areas demonstrating insignificant biological impacts; since 1971 these projects have totaled approximately 290,000 cu yd. An additional five projects, totaling 615,000 cu yd, are planned in clean operational areas. In conclusion, the dredging requirements in operational areas are approximately 75,000 cu yd per year and on average about 30% of the these sediments are unsuitable for ocean disposal. In addition, another 35% of these sediments may only be marginally suitable for ocean disposal.

An estimate of recent shoaling rates in the main navigation channels and turning basins was made as a part of this study by comparisons of recent bathymetric surveys. The results showed little shoaling since 1990 and were not helpful in predicting future dredging requirements for unsuitable material; therefore, future dredging requirements in the main channels were estimated based on the past dredging requirements. Since 1971 maintenance dredging of the main navigational channels and turning basins has been performed four times, in 1971, 1977, 1984, and 1990, and totaled 6,500,000 cu yd. Only a very small fraction of this volume (5 to 10%) was dredged from areas considered unsuitable for ocean disposal; similarly, only a small fraction (10 to 15%) of this volume was dredged from areas of questionable suitability for ocean disposal. In conclusion, the dredging requirements in the main channels are approximately 200,000 cu yd per year and on average less than 5% of the area being maintained in the main channels and lochs have sediments that are unsuitable for ocean disposal. In addition, another 15% of the area have sediments that may only be marginally suitable for ocean disposal.

Dredging is not performed in equal quantities annually; dredging projects are scheduled irregularly and vary greatly in size. Similarly, the fraction of a dredging project that is unsuitable for ocean disposal is not constant between projects nor does the fraction approximate the average. As such, the disposal requirements are highly variable. In the operational areas, the disposal requirements for unsuitable material varies from 0 to 150,000 cu yd. While on average only 25,000 to 50,000 cu yd of unsuitable sediments are dredged per year from the operational areas, the maximum disposal requirement in any given year may be as high as 300,000 cu yd due to the current backlog of dredging projects. Maintenance of the main channels is more likely to produce a more constant disposal requirement for unsuitable material because the work is more widespread. Approximately, 200,000 cu yd of sediments shoal in the main channels per year but the channels are dredged only once every 6 to 9 years. The disposal requirements for unsuitable material from the main channels are likely to range from 75,000 to 300,000 cu yd once every 6 to 9 years. Scheduling of dredging projects should be performed to produce a disposal sequence that is more uniform and compatible with the disposal alternatives. For example, dredging of contaminated operational areas should not be scheduled in the same year when maintenance dredging of the contaminated main channels is scheduled. Dredging of clean operational areas could be scheduled for the same year as maintenance of the main channels.

Disposal Requirements for LTMS

The average annual dredging requirement is approximately 275,000 cu yd. Biological testing of Pearl Harbor sediments indicates that approximately 15% of the material, approximately 40,000 cu yd per year, is unsuitable for ocean disposal. If marginally suitable material is determined to be unsuitable based on bioaccumulation testing, then the unsuitable fraction will rise to about 30%, or about 80,000 cu yd per year. For a 30-year LTMS period, the total required disposal volume would be about 1,600,000 cu yd. In addition, the disposal alternative should be able to handle up to 300,000 cu yd in a single year.

4 - Disposal Resources and Alternatives

General

This chapter describes the potential disposal alternatives that exist for material dredged from Pearl Harbor. Ocean disposal for suitable materials is an option assumed to be available for the future. The major consideration for this LTMS is appropriate disposal options and sites for materials found to be unsuitable for ocean disposal. Potential options considered for unsuitable materials include capped contained aquatic disposal (CAD) sites, upland confined (diked) disposal facilities (CDFs), upland dewatering and rehandling facilities with offsite upland disposal or reuse, in-water (nearshore) CDFs, and beneficial uses of the dredged material.

Dredged Material Disposal Alternatives

Four major types of alternatives are available for dredged material disposal: open-water disposal, contained aquatic disposal, confined disposal, and beneficial use. There are common processes and considerations for each of the respective alternatives, regardless of the site selected. General descriptions of each of the major alternatives are given in the following paragraphs.

As stated previously, the disposal of dredged material must be performed in accordance with the requirements of the National Environmental Policy Act (NEPA), the Clean Water Act (CWA), and the Marine Protection, Research, and Sanctuaries Act (MPRSA). As such, the evaluation of the environmental effects of dredged material management alternatives should follow the technical framework outlined in the USACE/EPA technical guidance document, "Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework" (USACE/EPA 1992).

Conventional Open-Water Placement

Open-water disposal is the placement of dredged material in rivers, lakes, estuaries, or oceans via pipeline, direct mechanical placement, or release from hopper dredges or barges. The main consideration for conventional use of an open-water site is whether a given material to be dredged is acceptable for open-water disposal from the standpoint of contamination. Water-column contaminant impacts must be considered from the standpoint of water quality (chemical) and toxicity (biological). Benthic impacts must be considered from the standpoint of toxicity and bioaccumulation. A tiered approach to open-water contaminant testing and assessments is described in detail in the dredged material testing manuals for MPRSA and CWA (USEPA/USACE 1991; USEPA/USACE, 1998).

The South Oahu Ocean Site is a designated ocean disposal site located with its center approximately 3.3 nautical miles offshore (see Figure 4). The EIS for site designation contains detailed information on the site characteristics and ocean placement operations (USEPA 1980). This site has a mean water depth of approximately 450 meters and is considered a predominantly accumulative site. Because of its great water depth, the capacity of the site is not considered a limiting factor for future use. For purposes of this LTMS, the South Oahu site is considered to be available for future placement of materials found to be suitable for ocean disposal.

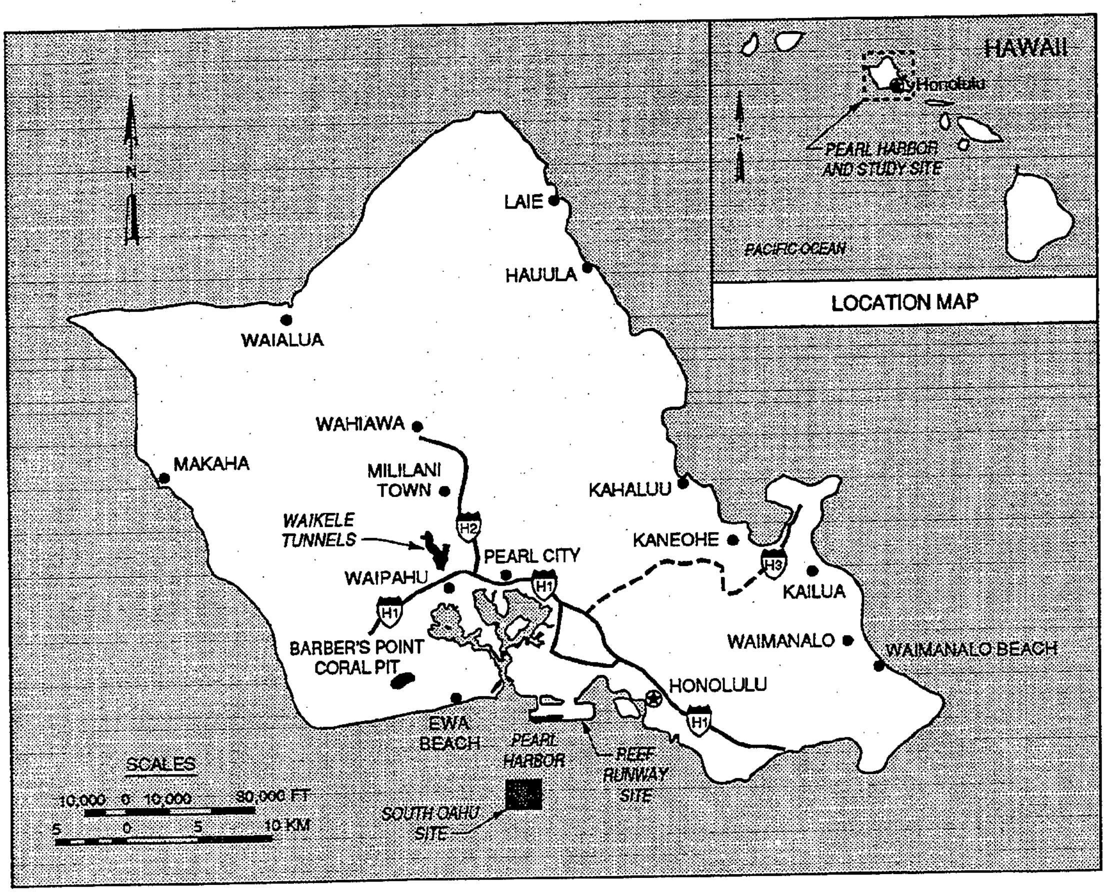

Figure 4. Map of potential disposal sites for Oahu naval facilities

Capping and Contained Aquatic Disposal

Capping is the controlled placement of contaminated material at an open-water site followed by a covering or cap of clean isolating material. Capping is a control measure for the benthic contaminant pathway. Level bottom capping is a term used for capping without means of lateral containment. If some form of lateral containment is used in conjunction with the cap, the term contained aquatic disposal (CAD) is used. Considerations in evaluating the feasibility of capping include site bathymetry, water depth, currents, wave climate, physical characteristics of contaminated sediment and capping sediment, and placement equipment and techniques. Because long-term stability of the cap is of concern, capping is generally considered to be more technically feasible in low-energy environments. Precise placement of material is necessary for effective capping, and use of other control measures such as submerged discharge and lateral containment increases the effectiveness of capping. Guidelines are available for planning and design of capping projects (Palermo 1991a, 1991b, 1991c; Palermo, Fredette, and Randall 1992). CAD sites pose no loss of aquatic habitat.

Confined (Diked) Disposal

Confined disposal is placement of dredged material within diked nearshore, upland, or island confined disposal facilities (CDFs) via pipeline or other means. The term CDF is used in this document in its broadest sense. CDFs may be constructed as upland sites, nearshore sites with one or more sides in water (sometimes called intertidal sites), or island sites completely surrounded by water. The two objectives inherent in design and operation of CDFs are to provide for adequate storage capacity for meeting dredging requirements and to maximize efficiency in retaining the solids. However, if contaminants are present, control of contaminant releases may also be an objective. Basic guidance for design, operation, and management of CDFs is found in EM 1110-2-5027 (USACE 1987a).

The four major components of the confined disposal assessment process are site selection and characterization, evaluation of direct physical impacts and site capacity, evaluation of contaminant pathways, and evaluation of management actions and contaminant controls. The intent of site selection is to avoid adverse impacts to the ecosystem, groundwater, and land use. In addition, site selection must consider the capacity of the site and long-term physical impacts. The evaluation of contaminant pathways is performed using a tiered approach as outlined in the framework for the Comprehensive Analysis of Migration Pathways (CAMP) (Brannon et al. 1990). Additional guidance for evaluating contaminant pathways and the effects of contaminant controls is given in "Estimating Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediments," Assessment and Remediation of

Contaminated Sediments (ARCS) Program EPA 905-R96-001 (Myers et al. 1996).

Use of CDFs at PHNC will involve a different approach for handling, transporting, and placement of the material at the site than has been used historically in Hawaii. Some of the CDF sites under consideration are located adjacent to or near the channels and project areas to be dredged, and some are located at some distance away. In most cases, CDFs are filled directly by pipeline from hydraulic pipeline dredges. In some cases, the sites are filled by hydraulic reslurry from barges or by direct pumpout from hopper dredges.

There are no known pipeline dredges in Hawaii at present. Because of the long distances to the islands from mainland areas, the mobilization and demobilization of a pipeline dredge to Hawaii would be very expensive. Purchase of a small pipeline dredge is an option which could be considered, but dredge ownership would present maintenance problems as well as institutional problems regarding the perception of competition with private industry. For these reasons, use of a pipeline dredge with direct pumping to a CDF will be unlikely. Pumpout from hopper dredges to nearby CDFs is a viable option for placement, when a hopper dredge can be used. For cases where a hopper dredge is not feasible, the use of clamshell for mechanical dredging is a viable option, with hydraulic reslurry from the barges. This rehandling operation would require use of a "mud pump" with water injection to reslurry the material. Another option is mechanical rehandling directly from the barges to trucks for transport to the CDF or directly to a nearshore CDF located immediately adjacent to suitable mooring facilities for the barges.

Beneficial Uses

Beneficial uses of the dredged material should always be a priority in developing an LTMS. Beneficial use includes a wide variety of options which utilize the material for some productive purpose. Ten broad categories of beneficial uses have been identified: habitat restoration or enhancement (wetland, upland, island, and aquatic); beach nourishment; aquaculture; parks and recreation; agriculture, forestry, and horticulture; strip mine reclamation and landfill cover; shoreline stabilization and erosion control (fills, artificial reefs, and submerged berms); construction and industrial use (port development, airports, urban, and residential); material transfer (fill, dikes, levees, parking lots, and roads); and multiple purpose. Detailed guidelines for beneficial use applications are given in EM 1110-2-5026 (USACE 1987b).

Preliminary Site Screening

The South Oahu site is presently used for materials acceptable for ocean disposal. The continued use of this site for acceptable materials is assumed. The major consideration for this LTMS is therefore disposal options and sites for materials which are found to be unsuitable for ocean disposal. Because the region is highly developed and land area is at a premium, no general siting study using land use overlay techniques was considered appropriate. Instead, potential options and sites were identified using a set of screening factors:

- o Capacity
- o Costs
- o Technology Availability
- o Technology Reliability
- o Logistical Requirements
- o Environmental Concerns
- o Regulatory Requirements
- o Public Acceptance

Only potential Navy sites and the potential State of Hawaii joint use facility at the Honolulu's airport reef runway are presented in this report. An initial screening and survey of offsite alternatives did not reveal any potential candidates. In addition, it was felt that Navy ownership would be necessary to provide the long-term control and availability of the disposal alternative.

The following Navy sites in the PHNC were screened as not being viable without further investigation in this study.

1) In-water disposal sites in West Loch were discarded as being too shallow to permit access to dredging vessels. West Loch is also considered to be too environmentally sensitive for disposal of contaminated sediments.

2) In-water disposal sites in Middle Loch were discarded because the site is in use by mothballed ships' moorings. In addition, the area is adjacent to a national wildlife refuge and the area is considered environmentally sensitive.

3) In-water nearshore sites in northern East Loch were discarded because the sites are too shallow and would have low public acceptance due to proximity of recreational and public lands.

4) Land west of West Loch was discarded as being proposed for development.

5) NAVMAG lands west of West Loch Channel and on the west side of Waipio Peninsula were discarded as being encumbered by the 60% arc of the Explosives Safety Quantity Distance (ESQD) zone.

6) Lands east of the main navigation channels (Entrance, Main, and South) are fully developed and therefore unavailable for a disposal facility.

7) Ford Island is unavailable because it is planned for development.

8) Pearl City Peninsula is unavailable because it is too developed.

9) Puuloa (west of the Entrance Channel) is fully developed.

In addition to screening out various disposal sites, mechanical dewatering was dropped from further consideration for the following reasons. Unsuitable material was predominantly in operational areas that are mechanically dredged which would negate the use of hydrocyclones. Belt filter presses, vacuum filtration, and pressure filtration would typically require a permanent facility that could not be located at the most desirable disposal sites. In addition, these facilities have a large capital cost that would not be warranted for the small and infrequent requirements for dredging at Pearl Harbor.

Potential Disposal Sites

Based on these screening criteria, several Navy sites (shown in Figures 4 and 5) were identified as potential candidates for materials unsuitable for ocean disposal: upper East Loch for a borrow and fill contained aquatic disposal (CAD) site, Waipio Peninsula for upland confined disposal, and two additional in-water nearshore confined disposal sites. Both nearshore facilities are along the eastern shore of Waipio Peninsula; one is a small cove adjacent to the channel across from Hospital Point, and the other is a small cove across from Ford Island below the degaussing station. In addition, there is potential for some beneficial use, primarily reuse of the upland disposal site or material for agricultural uses, such as for growing flowers, or filling abandoned tunnels at Waikele Tunnel or coral pits at Barber's Point. The characteristics of these sites are summarized in Table 8. Descriptions of each of the disposal options and sites along with pertinent information on each of the screening factors is given in the following paragraphs. Planning level cost estimates of proposed dredged material disposal alternatives are given in Appendix B.

East Loch Capped CAD Facility

A subaqueous area within the East Loch (shown in Figure 5) is proposed as a capped contained aquatic disposal (CAD) facility. This site is a former ammunition anchorage area circular in shape with a diameter of approximately 1000 ft. Additional area adjacent to the anchorage would be available if the need is established. The bottom at and surrounding the site is generally flat with a water depth of approximately 35 ft. The CAD facility would be developed by excavating the native sediments with a clamshell dredge to create

TABLE 8. POTENTIAL DISPOSAL ALTERNATIVES FOR DREDGED MATERIAL UNSUITABLE FOR OCEAN DISPOSAL

Potential Site	Disposal Method	Property Owner	Advantages	Disadvantages
East Loch Ammunition Anchorage	Confined Aquatic Disposal (CAD)	NAVSTA (Water)	1. No known plans to deepen. 2. Moorings are seldom used. 3. Short travel distance. 4. No dewatering.	1. Potential impact to caprock. 2. Use constraints due to operations. 3. SHPO coordination. 4. 401 WQ Permit required. 5. Long-term monitoring may be required.
Waipio Peninsula	Upland CDF	NAVMAG (Land)	1. Wharf W-22 at site eases off-loading. 2. Short travel distance. 3. Away from developed areas. 4. Existing retention ponds left from sugar cane operations.	1. ESQD access restrictions. 2. 401 WQ Permit required.
Reef Runway	Upland CDF	HI DOT	1. Short travel distance. 2. Easy to develop. 3. Isolated from development. 4. Available soon.	1. FAA restrictions. 2. HI DOT coordination. 3. Limited capacity. 4. 401 WQ Permit required.
Waipio Peninsula Shoreline	Nearshore CDF	NAVSTA (Water)	1. Short travel distance. 2. No dewatering.	1. Mitigation required. 2. Potential odor to Hospital Point. 3. Loss of shoreline. 4. 401 WQ Permit required.
Waikele Tunnel	Upland Beneficial Use	NAVMAG (Land)	1. 120 abandoned tunnels.	1. Long travel distance. 2. Hauling equipment required. 3. Insufficient capacity. 4. Material needs dewatering before placement.
Barber's Point	Upland Beneficial Use	Barber's Point	1. Existing coral pits considered contaminated.	1. Transfer difficult. 2. Dewatering required before placement into coral pits. 3. BRAC 4. Limited capacity.

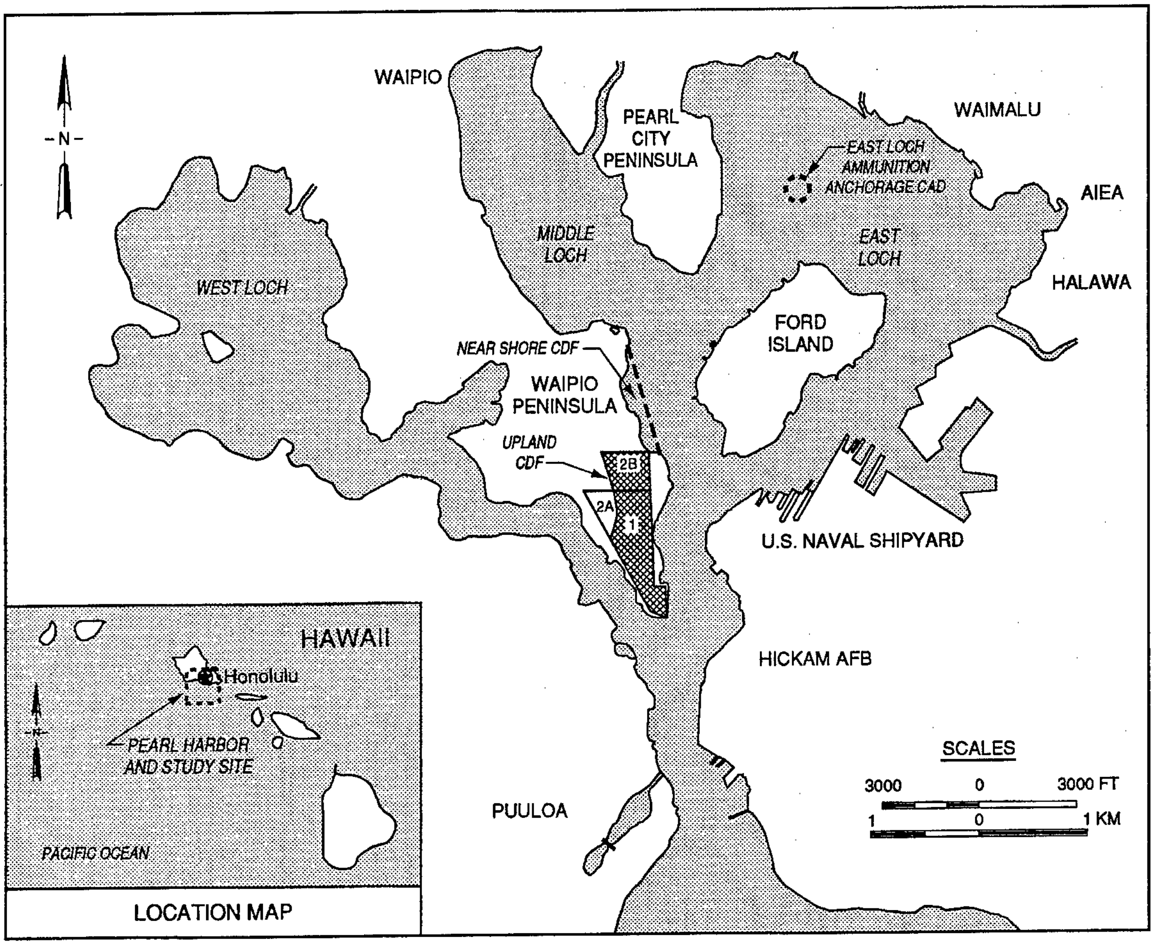

Figure 5. Disposal sites within the Pearl Harbor Naval Complex

subaqueous pits, one for each dredging project or dredging season. Excavated materials would be disposed in the South Oahu ocean site by dump scows or used beneficially offsite (e.g. as cover material for a CDF option). The pit would be filled with dredged material unsuitable for ocean disposal. The material would be mechanically dredged and placed by bottom dumping from a dump scow. The pit would be capped with clean material from the dredging project or from excavation of the next pit. The site will continue to be used as an anchorage area following filling and capping.

Capacity. With a diameter of approximately 900 ft and an assumed excavated depth of 50 ft, the site has an approximate volumetric capacity of over a million cubic yards. The volume of dredged material as measured in situ prior to dredging which could be placed in the site would be influenced by the dredging and placement method. The site has adequate capacity to meet the 30-year requirement.

Costs. The unit cost for disposal in the CAD site would be lower than that for a CDF. However, the cost of pit construction would be comparable to that for dredging and ocean disposal of material by clam and barge (about $10 per cubic yard). The unit cost for disposal at the CAD site (to include pit construction and capping) should range from $16 to $22 per cubic yard. (Cubic yards as referenced to costs for this and all other options refer to the in situ volume of dredged material.) This option is considered a low-cost option.

Technology Availability. Construction of the pit would involve clamshell dredge and barge. All equipment needed for construction, operation, and management should be readily available or acquirable in Hawaii.

Technology Reliability. Use of a CAD site for disposal involves only conventional and reliable technologies, including conventional dredging, GPS (global positioning system), bathymetric measurements, and monitoring.

Logistical Requirements. The CAD site is located near dredging areas and would provide for easy placement with dredging equipment. However, the depth to bedrock is unknown. If rock is present, the need for blasting would effectively eliminate the site from consideration.

Environmental Concerns. The CAD facility will disrupt the benthic community at the site. Release of contaminants to the water column during placement in the pit and exposures to benthos prior to capping need to be considered in developing designs and operations and management plans for the site. The cap design should consider the long-term flux of contaminants. Excavation of the pit also has the potential to impact deep water aquifers.

Regulatory Requirements. Use of this CAD site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii. Acquisition of a 404 permit may be difficult because open-water sites should be employed only when other alternatives are not available, technically or economically practicable, or environmentally sound. If the alternative can be justified, then a standard elutriate test and water column bioassay test must be performed to acquire the 404 permit and 401 water quality certification. Both of these tests are routinely performed to determine the suitability of the material for ocean disposal. Based on past testing, most of the material, if not all, is likely to meet water quality standards. If the material fails water quality requirements, an upland disposal facility would be needed for the project. In addition, settling tests, consolidation tests, and sediment characterization need to be performed to aid in design.

Public Acceptance. The site is aquatic, but aquatic habitat would be altered, not lost. It is considered to have medium public acceptance because of the potential impact to deep aquifers, loss of material and contaminants during disposal, disturbance of aquatic habitat and location is near public use areas.

Waipio Peninsula CDF

A proposed location for an upland CDF constructed on the southern tip of Waipio peninsula is shown in Figure 5. The Explosive Safety Quantity Distance (ESQD) arc encompasses the southern two-thirds of Waipio Peninsula. The area comprises two separate areas: Area 1 with approximately 88 acres, and Area 2b with approximately 36 acres (a third area, 2a, is not considered because of its location within 60% of the ESQD arc). The Navy has indicated a combination of Areas 1 and 2b is also possible. This CDF would be designed for final disposal and storage of the dredged material. As such, it would be designed to require minimal management (e.g. drainage and dike raising) and minimal maintenance (e.g. vegetation control and dike erosion repair). Under typical operation the dredged material would be hydraulically placed (pumped) into the facility and the excess water would be discharged through a weir structure back to the waterway. The facility may be subdivided into multiple cells to facilitate dewatering and desiccation and to increase management options. Closure and/or capping would be required only if the final material placed in the facility produces unacceptable runoff water quality or unacceptable plant or animal contaminant uptake. Additionally, closure may be performed to prepare the site for post-closure use; this would typically involve leveling of the dikes, filling of drainage trenches, and perhaps removing inlet and outlet structures. The disposal does not fall under the regulatory purview of RCRA and its closure requirements.

Capacity. This site would have an approximate surface area of up to 124 acres. The capacity of the site, if used for disposal without rehandling or future removal of material for beneficial use, would be dependent on the limiting height to which dikes could be constructed and maintained for efficient operations. For an assumed initial dike height of 12 ft with a fill height of 8 ft, the total volumetric capacity would be approximately 1,600,000 cu yd. This volume assumes no reduction of material volume due to dewatering and consolidation. Therefore, the site has more than adequate capacity to meet the 30-year requirement for material unsuitable for ocean disposal.

Costs. The unit cost for disposal at a land-based CDF (to include site construction, operation, and management) should range from \$5 to \$10 per cubic yard and from \$15 to \$20 per cubic yard if dredging is included. This option is considered a low-cost alternative.

Technology Availability. Construction and management of this upland CDF would involve conventional upland earthmoving equipment. Dikes for this site could be initially constructed using onsite soils removed from the site interior, resulting in increased capacity. Materials could be placed in the CDF by hydraulic pipeline, either directly from the dredging areas or from hydraulic off-loading facilities located adjacent or near the site (e.g., Whiskey 22 wharf). Once dredged material is placed in the site, a passive management program for dewatering should be implemented. This would consist of drainage following disposal, periphery trenching for minimal dewatering enhancement, and removing the dewatered material from the area adjacent to the dikes for use in upgrading the dikes. All equipment needed for construction, operation, and management should be readily available in Hawaii.

Technology Reliability. Use of a land-based CDF for disposal involves only conventional and reliable technologies, including earthwork, conventional dredging, slurrying, dewatering, and monitoring.

Logistical Requirements. Waipio peninsula provides easy access to and is near the dredging areas where materials unsuitable for ocean disposal are to be dredged. The site affords shoreline frontage which could be used for mooring facilities for hopper dredges or barges (wharf W22). The placement of material at this CDF could therefore be easily accomplished with hydraulic pumpout or hydraulic reslurry. Mechanical rehandling directly from barges to the CDF using a conveying chute arrangement or by truck is also possible for small volumes; however, equipment and manpower requirements for mechanical rehandling may be precluded by restrictions of the ESQD zone.

Environmental Concerns. The peninsula site is an ecologically disturbed area without useable groundwater and has low potential for environmental impacts. The construction of a CDF would result in changes to the habitat value of the site. The contaminant levels of the materials to be placed at the site need to be considered in developing a management plan for the site. Contaminant pathways for effluent discharge during filling, surface water quality due to precipitation runoff, leachate to groundwater, and direct uptake by plants and animals should be evaluated in the planning study and managed appropriately in site design and development of operations and management plans. The testing requirements are given in Table 1.

Regulatory Requirements. Use of this CDF site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii. Contaminant pathway testing should be performed to demonstrate environmental protection. Column settling tests, a modified elutriate test, and a water column bioassay test on elutriate must be performed to acquire the 404 permit and 401 water quality certification. These tests differ from the tests routinely performed to determine the suitability of the material for ocean disposal. Additionally, water quality tests for surface runoff from anaerobic and oxidized sediments are needed to permit runoff discharges. Based on past testing, most of the material, if not all, is likely to meet water quality standards. Management options are available to control the contaminant pathways and therefore a 404 permit and a 401 water quality certification should be easy to obtain because the material is being removed from the water and aquatic habitat would be protected.

Public Acceptance. The site is on Navy property within a restricted zone and is isolated from direct public access. It is considered to have high public acceptance due to its remoteness and minimal environmental concerns.

Dewatering and Rehandling Facility on Waipio Peninsula CDF

This option is identical to the one above with the exception of periodic removal of dewatered material from the site interior for beneficial use offsite. As such, the site is more actively managed to insure that the material layers are thinner and dewater and desiccate rapidly. For example, the site may be trenched between disposal projects to promote desiccation. Also, the site may be managed to maximize infiltration to increase the rate of salt leaching from the material prior to recovery. When the material is ready for beneficial use, the material would be scraped from the facility and transported immediately or stockpiled at the site for future area, readying the facility for additional disposal. If the volumes placed in the site and those removed and used offsite are equivalent, the site would serve as a temporary storage site and would have an infinite life. The site would therefore serve as a permanent generating site for materials for beneficial use.

Capacity. A rehandling site could be constructed and maintained as a permanent facility on the southern tip of Waipio Peninsula. Potentially a smaller site could be constructed, but a site of similar geometry to that shown in Figure 5 would probably be needed to provide sufficient surface area for efficient dewatering, a necessity for subsequent offsite use. The capacity of the site could be considered in terms of the "throughput" of materials removed from the site for beneficial use. If the volumes placed in the site exceed those which can be removed and used offsite, the site would have a finite life since the limiting dike height would eventually be reached. Since the site is to be operated as a permanent facility with only temporary storage of material, the facility would have adequate capacity.

Costs. The unit cost for disposal at a land-based CDF with rehandling (to include site construction, operation, management, and rehandling to an offsite location) should range from $8 to $14 per cubic yard, $16 to $22 per cubic yard including dredging. This cost includes dewatering activities and use of low-ground pressure equipment. This cost does not include any monetary benefits derived from the beneficial use nor any payments from the beneficial use “owner” to defray rehandling costs. This option is low cost.

Technology Availability. The construction and management of the upland CDF as a rehandling facility would be similar to that required for a disposal facility only. The exception would be a more intensive dewatering effort. This may involve use of low-ground pressure equipment for interior dewatering operations. Low-ground pressure dozers may also be required to "mine" the dewatered material from the site interior. Low-ground pressure equipment may not be readily available in Hawaii, but could be mobilized or purchased at a reasonable cost.

Technology Reliability. Use of a land-based CDF for rehandling involves only conventional and reliable technologies, including conventional dredging, slurrying, dewatering, earthwork, and monitoring.

Logistical Requirements. Logistics for construction and operation of a rehandling facility at Waipio peninsula are similar to those for a disposal facility. The easy access would allow for efficient reclamation of dewatered material and transport offsite.

Environmental Concerns. The environmental concerns for a rehandling facility at Waipio Peninsula are similar to those for a disposal facility at Waipio Peninsula. Such a site would have low potential for environmental impacts. Contaminant pathways for effluent discharge during filling, surface water quality due to precipitation runoff, and leachate to groundwater should be evaluated in the planning study and managed appropriately in site design and development of operations and management plans. The testing requirements are given in Table 1.

Regulatory Requirements. Use of this CDF site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii. Testing requirements are the same as those described for the Waipio Peninsula CDF. Additional regulatory requirements (e.g., RCRA) would apply to the use of material offsite and would be dependent on the specific use.

Public Acceptance. The site is on Navy property and is isolated from direct public access. Public acceptance for this option would be greater since the site could be smaller than a disposal site and materials would be beneficially used. This alternative poses minimal environmental concerns and is considered to have high public acceptance.

Manufactured Topsoil Facility

This alternative is very similar to the one above for a dewatering and rehandling facility at Waipio Peninsula. The dewatering, desalination, and temporary storage of dredged material would be located on the southern tip of Waipio Peninsula. The only difference is that provisions would be provided for manufacturing a topsoil product by mixing dredged material with other materials such as compost and inert materials, providing for beneficial use of the dredged material and other waste materials. The dredged material could be transported to the soil manufacturing facility or the other materials could be brought to the dredged material dewatering and rehandling facility.

Capacity. As with the rehandling site, a manufactured soil site could be constructed and maintained as a permanent facility. The capacity of this alternative would be controlled by the proportion of dredged material in the topsoil product, the quantity of compost, and the need for topsoil. Since the site is to be operated as a permanent facility with removal of material for topsoil manufacturing, the facility would have adequate capacity. The potential need for dredged material is estimated to be 40,000 to 80,000 cu yd/year based on annual production quantity of compost and the typical proportions of dredged material used in manufacturing topsoil. This need is similar to the long-term dredged material production rate.

Costs. The unit cost for manufacturing soil would vary greatly depending on the desalinization requirements. The unit cost (including site construction, dredging, operation, management, desalination, mixing and processing of soil, and removal and transport to an offsite use) should range from $35 to $45 per cubic yard. This cost would not include any monetary benefits derived from the sale or use of the soil product. This option is considered medium cost, considering the recoverable costs from sales or savings.

Technology Availability. The construction and management of the soil facility would require the same technologies for dewatering and mining as those for a rehandling facility. In addition, provisions must also be made for desalination of the material. This could be accomplished by leaching of the saltwater by infiltration of precipitation during and following the dewatering process. The soil manufacturing process would require equipment and preparation facilities for stockpiling, applying, and mixing the other soil components with dewatered dredged material. As with the rehandling facility, low-ground pressure equipment may be needed.

Technology Reliability. Soil manufacturing involves only conventional and reliable technologies, including conventional dredging, slurrying, dewatering, leaching, earthwork, and monitoring.

Logistical Requirements. Logistics for construction and operation of a soil manufacturing facility are similar to those for a rehandling facility at Waipio Peninsula. Additional logistical considerations apply to the maintenance of a sufficient stockpile of material to provide the stream of material as required by the topsoil manufacturing and to transport the dredged material to the manufacturing site, if offsite.

Environmental Concerns. The environmental concerns for a topsoil manufacturing facility are similar to those for a rehandling facility. No additional environmental concerns would be posed by the actual manufacturing facility where the dredged materials would be mixed with compost, ash, or inert materials. Such a site would have low potential for environmental impacts.

Regulatory Requirements. Use of this CDF site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii for the dredging and disposal of material with a discharge from the dewatering and rehandling facility. Testing requirements are the same as those described for the Waipio Peninsula CDF. Additional regulatory requirements (e.g., RCRA) would apply to the use of material offsite and would be dependent on the specific use.

Public Acceptance. This option is considered to have high public acceptance because the material would be used beneficially and the alternative has minimal environmental impacts.

Reef Runway CDF

The Hawaii Department of Transportation (DOT) Airport Division is currently managing a site adjacent to the Reef Runway at Honolulu International Airport which has been proposed for use as a dredged material CDF. This site was filled with material excavated during construction of an access channel adjacent to the airport. The site is located adjacent and parallel to the reef runway as shown in Figure 4, and is approximately 1000 ft wide and over 2.5 miles long. A rubble-mound breakwater encloses the site on the ocean side. The site is presently a RCRA permitted soil management facility for remediation of soils contaminated with volatile organics such as jet fuels. To date, only a small volume of soil has been placed at the site. The site has also been proposed as a potential CDF for material to be dredged from the Ala Wai canal project in Wakiki. Because of these present and potential uses, only a portion of the site, the western half, would potentially be suitable for use as a CDF for Navy projects. This CDF would be designed for final disposal and shallow storage of the dredged material. As such, it would be designed to require minimal management (e.g. drainage and dike raising) and minimal maintenance (e.g. vegetation control and bird control). Under typical operation the dredged material would be hydraulically placed (pumped) into the facility, and the excess water would be discharged through a weir structure back to the waterway. Closure and/or capping would be required only if the final material placed in the facility produces unacceptable runoff water quality or unacceptable plant or animal contaminant uptake. Additionally, closure may be performed to prepare the site for post-closure use; this would typically involve leveling of the dikes, filling of drainage trenches, and perhaps removing inlet and outlet structures. The disposal does not fall under the regulatory purview of RCRA and its closure requirements.

Capacity. The current fill elevation of the site is approximately +3.0 ft. The current runway elevation is +10.0 ft. There are restrictions on the elevation of any structure or fill adjacent to the runway, and these restrictions must be clarified before the capacity of the site can be precisely determined. Assuming that only half of the site could be made available for a CDF, and that the fill height would be limited to +7.0 ft, the capacity could be as large as 1,000,000 cu yd. This volume assumes no reduction of material volume due to dewatering and consolidation. The site, therefore, has adequate capacity to meet at least 20 years of the disposal requirement for material unsuitable for ocean disposal. However, the DOT is presently willing to consider disposal of up to 300,000 cu yd of Navy sediments; this would provide adequate storage capacity for about 3 to 5 years.

Costs. The unit cost for disposal at a land-based CDF (to include site construction, operation, and management) should range from $15 to $20 per cubic yard including dredging. This option is low cost.

Technology Availability. Construction and management of this upland CDF would involve conventional upland earthmoving equipment. Dikes for this site could be initially constructed using onsite soils removed from the site interior, resulting in increased capacity. Materials could be placed in the CDF from hydraulic off-loading facilities located adjacent to the site. Once dredged material is placed in the site, a passive management program for dewatering should be implemented. This would consist of draining following disposal, periphery trenching for minimal dewatering enhancement, and removing the dewatered material from the area adjacent to the dikes for use in upgrading the dikes. All equipment needed for construction, operation, and management should be readily available in Hawaii. Being located at the airport, bird control will be necessary. Bird control can be accomplished by employing netting and actively dewatering the site to eliminate freshwater pools.

Technology Reliability. Use of a land-based CDF for disposal involves only conventional and reliable technologies, including earthwork, conventional dredging, slurrying, dewatering, and monitoring.

Logistical Requirements. The existing channel provides easy access to the site, but the material would require transport by barges from Pearl Harbor to the site. The placement of material at this CDF could be easily accomplished with hydraulic pumpout or hydraulic reslurry. Mechanical rehandling directly from barges to the CDF using a conveying chute arrangement is also possible for small volumes.

Environmental Concerns. The runway site is a disturbed area without useable groundwater and has low potential for environmental impacts. The construction of a CDF would result in changes to the habitat value of the site. The contaminant levels of the materials to be placed at the site should be considered in developing a management plan for the site. Contaminant pathways for effluent discharge during filling, surface water quality due to precipitation runoff, leachate to groundwater, and direct uptake by plants and animals should be appropriately considered in site design and development of operations and management plans. The testing requirements are given in Table 1.

Regulatory Requirements. A major regulatory consideration for this site is its current designation as a RCRA permitted soil management facility. The entire site is currently permitted for this use. However, the entire area is not required for soil remediation, and the Airport Division would favorably consider a modification to the RCRA permit to restrict the waste disposal to only a small portion of the total site. The separation of any site to be used as a dredged material CDF from the existing RCRA permit is essential. Use of the site for a dredged material CDF would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii.

Public Acceptance. The site is on Airport Division property and is currently permitted as a RCRA soil management facility. The site is isolated from direct public access. It is considered to have high public acceptance.

Stabilized Fill Material Facility

This alternative provides for immediate dewatering of mechanically dredged material by the addition of stabilizing agents (e.g., portland cement or ash). The mixing and rehandling equipment could be land-based or barge-mounted. All handling of the material would be done mechanically, not hydraulically, to minimize the quantity of stabilizing agents needed. Stabilizing agents could be added on land or in the transfer barge. The stabilized material would then be stockpiled on land or transported to the fill site. The product would be suitable for structural or nonstructural fill. Additional area or barges would be required for the storage of the stabilizing agent. The facility could be located on Waipio Peninsula or Pearl City Peninsula at existing wharves or docks.

Capacity. As with the rehandling site, a stabilized fill facility could be constructed and maintained as a permanent facility. All material is removed for use as fill and the site would have a limitless capacity.

Costs. The unit cost for the facility (to include site construction, operation, dredging, management, stabilization, and removal and transport to an offsite use) should range from $40 to $55 per cubic yard. This cost would not include any monetary benefits derived from the use of the fill. This option is considered high cost.

Technology Availability. The construction and management of the facility would require technologies for material handling similar to those for a rehandling facility. In addition, provisions must also be made for stabilization of the material. This could be accomplished by equipment brought temporarily onsite for applying and mixing the stabilizing agent with the dredged material and then processing (curing, mixing, and stockpiling) the stabilized material. The equipment required for applying and mixing stabilizing agents with the dredged material is not available off-the-shelf. Systems are usually developed for the project using available equipment.

Technology Reliability. Dredged material stabilization involves use of only conventional and reliable technologies, but the process requires determination of site-specific parameters for mixture composition, curing time, and mixing. The success of chemical stabilization is a marginally proven technology.

Logistical Requirements. Logistics for construction and operation of a stabilization facility are similar to those for a rehandling facility. Additional logistical considerations apply to the stabilization process.

Environmental Concerns. The environmental concerns for a stabilization facility are similar to those for a rehandling facility, except for the absence of return water and leachate. Such a site would have low potential for environmental impacts. Use of the stabilized material would have low potential for impact offsite if leaching is controlled.

Regulatory Requirements. Use of stabilization would likely have minimal needs for a discharge of water, but a discharge would require a Section 404 permit from the USACE and a Section 401 water quality certification from the State of Hawaii. A Section 10 permit from the USACE would be needed for the dredging and off-loading operations. RCRA regulatory requirements may apply to the use of stabilized material offsite, but it would be dependent on the specific use.

Public Acceptance. This option is considered to have high public acceptance because the material would be beneficially used and pose minimal environmental impacts.

Waipio Peninsula Nearshore CDF

A proposed location for a nearshore CDF constructed along the eastern shore of Waipio peninsula is shown in Figure 5. The area would be enclosed on its eastern side by a dike constructed in the water along the edge of the navigation channel. The shoreline would provide the western portion of the enclosure. Dredged material would be placed in the site either hydraulically or mechanically. Under typical operation the dredged material would be hydraulically placed (pumped) into the facility, and the excess water would be discharged through a weir structure back to the waterway. Closure and/or capping would be required only if the final material placed in the facility produces unacceptable runoff water quality, or unacceptable plant or animal contaminant uptake. Additionally, closure may be performed to prepare the site for post-closure use; this would typically involve leveling of the dikes, filling of drainage trenches, and perhaps removing inlet and outlet structures. The disposal does not fall under the regulatory purview of RCRA and its closure requirements.

Capacity. This site would have an approximate surface area of 20 acres. The average water depth in the area is approximately 13 ft. The capacity of the site would be dependent on the limiting height to which dikes could be constructed and maintained for efficient operations. For an assumed dike height of 7 ft above mean high water, the fill height would be approximately 20 ft, and the total volumetric capacity would be approximately 645,000 cu yd. This volume assumes no reduction of material volume due to dewatering and consolidation. Therefore, the site has inadequate capacity to meet the 30-year requirement; it is sufficient for only about 10 years of disposal. Additionally, the small size of the site may limit the size of the disposal projects if the disposal lift thickness is kept small enough to facilitate reuse of the area after the capacity of the site is exhausted.

Costs. The unit cost for disposal at a nearshore CDF (to include site construction, operation, dredging, and management) is higher than that at an upland site due to the required marine construction and should range from $20 to $30 per cubic yard. This is considered a medium cost option.

Technology Availability. Construction of a nearshore CDF dike would involve marine construction equipment. Dikes for this site could be initially constructed using stone placed from barges. Sheet pile structures could also be considered. Materials could be placed in the CDF by hydraulic pipeline, either directly from the dredging areas or from hydraulic off-loading facilities located adjacent to or near the site. All equipment needed for construction, operation, and management should be readily available in Hawaii.

Technology Reliability. Use of a nearshore CDF for disposal involves only conventional and reliable technologies, including conventional dredging, slurrying, dewatering, and monitoring.

Logistical Requirements. Waipio peninsula provides easy access to and is near the dredging areas where materials unsuitable for ocean disposal are to be dredged. The site affords shoreline frontage which could be used for mooring facilities for hopper dredges or barges. Therefore, the placement of material at this CDF could be easily accomplished with hydraulic pumpout or hydraulic reslurry. Mechanical rehandling directly from barges to the CDF using a conveying chute arrangement is also possible.

Environmental Concerns. Construction of a nearshore site would involve loss of aquatic habitat (this area is viewed as a valuable spawning ground), and mitigation would be required. As for an upland CDF, the contaminant levels of the materials to be placed at the site should be considered in developing a management plan for the site. Contaminant pathways for effluent discharge during filling, surface water quality due to precipitation runoff (in the latter stages of filling), leachate to groundwater, and direct uptake by plants and animals should be evaluated in the planning study and managed appropriately in site design and development of operations and management plans. The testing requirements are given in Table 1.

Regulatory Requirements. Use of this CDF site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii. A Section 404 permit and a Section 401 water quality certification are required for the discharge waters. Acquisition of a permit may be difficult because aquatic sites should be employed only when other alternatives are not available, technically or economically practicable, or environmentally sound. If the alternative can be justified, then contaminant pathway testing should be performed to demonstrate environmental protection. Column settling tests, a modified elutriate test, and a water column bioassay test on elutriate must be performed to acquire the 404 permit and 401 water quality certification. These tests differ from the tests routinely performed to determine the suitability of the material for ocean disposal. Additionally, water quality tests for surface runoff from anaerobic and oxidized sediments are needed to permit runoff discharges. Based on past testing, most of the material, if not all, is likely to meet water quality standards.

Public Acceptance. The site is on Navy property and would create additional new land for future development. It is considered to have low public acceptance due to the loss of aquatic habitat and alteration of natural shoreline.

Waikele Tunnels

The Waikele tunnels site is a series of 120 abandoned ammunition storage tunnels. This site is located several miles from the PHNC (see Figure 4). Material would require dewatering or stabilization prior to placement in the tunnels. Therefore, a facility similar to that described for the rehandling facility or stabilized fill facility at Waipio peninsula would be required.

Capacity. Each tunnel is approximately 180 ft by 18 ft by 10 ft. The total volumetric capacity is approximately 144,000 cu yd. This is a straight volumetric capacity. The volume of dredged material as measured in situ prior to dredging which could be placed in the tunnels would be influenced by volume changes due to dewatering and the stabilization process. The site has inadequate capacity to meet the 30-year requirement; the capacity is sufficient for only a few years.

Costs. The tunnels now have a reinforced concrete baffle which would have to be removed prior to use for placement. The unit cost for disposal in the tunnels (to include removal of the baffles, dredging, operation of a stabilization facility, transport and placement) could range from $55 to $70 per cubic yard and is considered a high cost option.

Technology Availability. Removal of the baffles could be done with conventional equipment. The size of the tunnels would require small earthmoving equipment for placement of the material. All equipment needed for demolition and placement should be readily available in Hawaii.

Technology Reliability. Use of the tunnels for disposal involves only conventional and reliable technologies, including earthwork, conventional dredging, slurrying, dewatering, rehandling, trucking, and monitoring.

Logistical Requirements. The Waikele tunnel site is located far from dredging areas and would require extensive dewatering, treatment by stabilization, and rehandling for placement. Direct transport of stabilized material to the site by truck from the dewatering and stabilization facility would be required.

Environmental Concerns. The tunnels are a disturbed area where there is low potential for environmental impacts. Since the material would be stabilized, contaminant pathways are not of concern.

Regulatory Requirements. Dredging will require a Section 10 permit from the USACE. Discharge of water from the rehandling or stabilization site will require a Section 404 permit from the USACE and a Section 401 water quality certification from the State of Hawaii. Use of this site may require a RCRA Subtitle C or D permit from the State of Hawaii for disposal of a solid waste if the state chooses to recognize this operation as an action separate from the dredging. Acquisition of a RCRA permit would require a TCLP test. Other requirements are given in sections on the rehandling and stabilization facility.

Public Acceptance. The site is on Navy property but is scheduled for transfer to the private sector. Filling with dredged material should be considered a beneficial use and restoration of a disturbed site. Access to the site is through a residential neighborhood, and truck traffic would present concerns about safety, fugitive dust, traffic, and road maintenance. It is considered to have low public acceptance. Coordination would be needed with the State of Hawaii Department of Health, Solid and Hazardous Waste Branch.

Barber's Point Coral Pit CDF

A proposed location for an upland CDF within an existing excavated coral pit is at Barber's Point (see Figure 4). The site is a pit excavated below existing ground level and, therefore, would require little or no dike construction. Using the pit as a CDF would involve direct placement of dredged material to the pit without prior dewatering, rehandling, stabilization, etc. Therefore, the site would be operated and managed in much the same way as an upland CDF. The major difference would be related to the manner in which effluent would be discharged from the site during filling. A sump and pump operation would be required for discharge of effluent during any hydraulic filling and for removal of precipitation. Since the site lies below existing ground level, dewatering due to drying would be difficult, but consolidation would result in removal of much of the excess water. In addition, vertical strip drains could be employed after the surface desiccates and firms to consolidate the entire depth of fill. Material could be transported to the site by hydraulic pipeline if a mooring facility is constructed nearshore. Trucking material rehandled from barges is also a possible, but more expensive, option.

Capacity. The site would be filled to existing ground level. The site has a surface area of approximately 9 acres and was excavated to a depth of about 30 ft. The capacity of the site is therefore approximately 435,000 cu yd. Therefore, the site has inadequate capacity to meet the 30-year requirement; its capacity is sufficient for about 7 years of disposal.

Costs. The unit cost for disposal at an existing pit would not require any extensive dike construction. However, some training dikes and weirs would still be required to control release of excess water. Transportation costs would be higher than onsite facilities, since the distance of the site from the dredging areas would require transport to a mooring and pump-out facility or trucking. The unit cost for this site (to include minimal site preparation, construction, operation, and management) should range from $20 to $25 per cu yd and is considered a low cost site. Dewatering and consolidation of the site with vertical strip drains would add a cost of about $1 to $2 per cu yd.

Technology Availability. Operation and management of this site would involve conventional equipment. Any required training dikes for this site could be constructed using onsite soils. All equipment needed for construction, operation, and management should be readily available in Hawaii.

Technology Reliability. Use of a land-based pit CDF for disposal involves only conventional and reliable technologies, including earthwork, conventional dredging, slurrying, dewatering, and monitoring.

Logistical Requirements. The Barber's Point pit is located far from dredging areas and would require rehandling for placement. The site is not adjacent to shoreline frontage; therefore, a pipeline must be placed from any mooring facility across a developed area. Direct transport of material to the site by truck from an off-loading facility near the dredging areas is also possible.

Environmental Concerns. The pit is a disturbed and contaminated area without potable groundwater and has low potential for environmental impacts. The contaminant levels of the materials to be placed at the site should be considered in developing a management plan for the site. Contaminant pathways for effluent discharge during filling and leachate to groundwater should be appropriately considered in site design and development of operations and management plans. Since the site would be capped for future use, surface runoff and uptake by plants and animals are not of concern. The testing requirements are given in Table 1.

Regulatory Requirements. Use of this CDF site would require Section 10 and Section 404 permits from the USACE and a Section 401 water quality certification from the State of Hawaii for discharge of effluent from the facility. Testing requirements are the same as those described for the Waipio Peninsula CDF.

Public Acceptance. The site is on Navy property and is on part of a larger parcel that is proposed for conveyance to the City and County of Honolulu. Filling with dredged material should also be considered a beneficial use and restoration of a disturbed site. It is considered to have high public acceptance.

Barber's Point Coral Pit Remediation

Remediation of the Barber's Point Coral Pit (see Figure 4) is an option similar to the CDF option for the same site described above. However, the remediation option would involve placement of dewatered and, possibly, stabilized material at the site in engineered layers and perhaps with a liner system. This would require the use of another site, such as a dewatering and rehandling facility as the one proposed for Waipio Peninsula.

Capacity. The site would be filled to existing ground level with dewatered material. The site has a surface area of approximately 9 acres and was excavated to a depth of about 30 ft. The 435,000-cu yd capacity of the site for this option would be used for dewatered material. Dewatered material would occupy 50 to 70 % of the volume of in situ material; therefore, the site would have adequate capacity for about 700,000 cu yd of in situ material, meeting as much as required for 20 years of disposal.

Costs. The unit cost for pit remediation would require controlled placement of material layers. The cost of dredging plus the dewatering/rehandling facility or stabilization facility must also be included. The unit cost for this site using dewatered material should range from $25 to $30 per cubic yard and is considered a medium cost option. The unit cost for this site using stabilized material should range from $55 to $65 per cubic yard and is considered a high cost option.

Technology Availability. Only conventional construction equipment would be needed for this option, once the dewatered/stabilized material is delivered for placement. All equipment needed for placement should be readily available in Hawaii.

Technology Reliability. Placement of dewatered/stabilized material in the pit involves conventional and reliable technologies, consisting primarily of material handling, trucking, and earthwork besides the technologies employed at the rehandling or stabilization facility.

Logistical Requirements. Direct transport of material to the site by truck from the dewatering/stabilization facility is necessary.

Environmental Concerns. The pit is a disturbed and contaminated area without potable groundwater and has low potential for environmental impacts. The nature of the dewatered/stabilized material should be considered in the design of the layers to be placed. Contaminant pathways for effluent discharge during filling and leachate to groundwater should be appropriately considered in site design and development of operations and management plans. Since the site would be capped for future use, surface runoff and uptake by plants and animals are not of concern. The testing requirements are given in Table 1.

Regulatory Requirements. Use of this site would require a RCRA Subtitle C or D permit from the State of Hawaii because transfer of this material to the pit in a dewatered state is not incidental to the dredging and initial disposal. In addition to a RCRA solid waste disposal permit, the permits for the dredging and disposal for the rehandling or stabilization facility are needed.

Public Acceptance. The site is on Navy property and is on part of a larger parcel that is proposed for conveyance to the City and County of Honolulu. Filling with dredged material should also be considered a beneficial use and restoration of a disturbed site. The option would have low environmental impact and, therefore, is considered to have high public acceptance.

5 - Summary, Conclusions, and Recommendations

This chapter presents a discussion of the findings and conclusions made as a result of the Phase I effort. Recommendations for Phase II are also presented.

Summary and Conclusions from Phase I Effort

A number of disposal alternatives are available for dredged material that is unsuitable for ocean disposal. The alternatives are summarized in Table 9. Several of the alternatives by themselves can provide adequate capacity for the next 30 years. The costs of the alternatives are a function of the alternative; some are slightly higher than open water disposal, while others are much higher. Most of the alternatives would have high public acceptance and low environmental impacts.

Geographic Limits and Time Frame for LTMS

NAVSTA is responsible for dredging activities to maintain navigation at the PHNC. Most of the dredged material from these projects has been historically placed at a designated ocean disposal site, but more recent testing requirements are indicating a percentage of the total material to be dredged is unsuitable for ocean disposal. Sites for this material must be identified and developed for use. Therefore, an LTMS for dredged material disposal is required for these projects. Considering the locations of the dredging areas and potential disposal areas, the geographic limits for the LTMS should encompass the entire island of Oahu. A 30-year disposal capacity was assumed as the time frame for the LTMS.

Dredging Requirements

Dredging is required in both operational areas and in the main navigation channels. Approximately 30% of the sediments requiring dredging in operational areas is assumed to be unsuitable for ocean disposal based on the on-going RI study findings on toxicity of surficial sediments. Another 30% may also be marginally unsuitable based on RI study findings on reduced

TABLE 9. SUMMARY OF SITE CHARACTERISTICS AND SITE SCREENING RESULTS

Site	Rating	Capacity, cu yd	Total Costs* (per cubic yard basis)	Environmental Concerns	Regulatory Requirements	Public Acceptance
Waipio Peninsula CDF	Best	1,600,000	$15.5 to $17.9	Surface water discharges, uptake	404 Permit and 401 WQ Certification	High
Reef Runway CDF	Good	300,000	$17.7	Surface water discharges, uptake	404 Permit and 401 WQ Certification	High
Dewatering and Rehandling Facility on Waipio Peninsula CDF	Good	300,000 per year	$17.4 to $20.5	Surface water discharges	404 Permit, 401 WQ Certification, and Special Use	High
Manufactured Topsoil Facility	Good	80,000 per year	$37.2 less benefits	Surface water discharges	404 Permit, 401 WQ Certification, and Special Use	High
Barber's Point Coral Pit CDF	Fair	450,000	$21.3	Surface and groundwater discharges, uptake	404 Permit and 401 WQ Certification	High
East Loch Capped CAD Facility	Fair	1,500,000	$18.5	Aquifer	404 Permit and 401 WQ Certification	Medium
Waipio Peninsula Nearshore CDF	Fair	650,000	$20.4 to $28.4	Loss of aquatic habitat, surface water discharges	404 Permit and 401 WQ Certification	Low
Barber's Point Coral Pit Remediation	Fair	700,000	$26 (dewatered) $58 (stabilized)	Surface water discharges	RCRA Subtitle C or D Permit, 404 Permit, and 401 WQ Certification	High
Stabilized Fill Material Facility	Poor	300,000 per year	$56.2 less benefits	Surface water discharges	404 Permit, 401 WQ Certification, and Special Use	High
Waikele Tunnels	Poor	144,000	$60.4	Surface water discharges	RCRA Subtitle C or D Permit, 404 Permit, and 401 WQ Certification	Low

* Costs per cubic yard of in situ sediment dredged (details in Appendix B).

fertilization. Similarly, approximately 5% of the sediment to be dredged from the main navigation channels is assumed to be unsuitable for ocean disposal and another 10 to 15% of the sediments is assumed to be only marginally suitable for ocean disposal. Dredging of the operational areas, averaging 75,000 cu yd per year, has typically been performed by mechanical clamshell dredges. Previous maintenance dredging of the main channels, averaging 200,000 cu yd per year, has been performed by the hopper dredge *Essayons*.

The average annual dredging requirement is approximately 275,000 cu yd. Biological testing of Pearl Harbor sediments indicates that approximately 15% of the material, approximately 40,000 cu yd per year, is unsuitable for ocean disposal. If marginally suitable material is determined to be unsuitable based on bioaccumulation testing, then the unsuitable fraction will rise to about 30% or about 80,000 cu yd per year. For a 30-year LTMS period, the total required disposal volume would be about 1,600,000 cu yd. In addition, the disposal alternative should be able to handle up to 300,000 cu yd in a single year.

Material Characteristics

Previous physical testing showed that sediment from upper areas of Pearl Harbor was primarily fine-grained lagoonal silt with clay, while sediment from lower channels was primarily sand. Previous chemical analyses performed on the sediments indicated that metals and some organic contaminants were present, but concentrations were low. Most areas exhibit insignificant toxicity and bioaccumulation, but some areas exhibit both statistical significant toxicity and bioaccumulation, albeit at low values.

Environmental Resources

The waters of Pearl Harbor are a significant habitat for numerous organisms; therefore, disposal of sediments and upland disposal discharges of effluents into Pearl Harbor will require careful evaluation of their environmental impacts. In almost its entirety, the land in the Pearl Harbor Naval Complex is developed or ecologically disturbed. As such, outside of national wildlife refuge areas and wetlands, there are not many upland environmental resources.

Disposal Alternatives

Disposal alternatives identified as available options during Phase I included contained aquatic disposal, confined disposal, and beneficial uses. A summary of the disposal site capacities and characteristics is shown in Table 9. Upland disposal in a CDF on Waipio Peninsula would be the least costly and most technically feasible and implementable alternative. Other alternatives which provide for beneficial use of the dredged material would typically require an upland disposal site as a storage and preparation area prior to implementation of the beneficial use. The Reef Runway CDF could supplement the Waipio CDF to meet short-term disposal requirements.

Comparison of Dredging Requirements and Disposal Resources

The total dredging requirement of sediments unsuitable for ocean disposal for a 30-year time frame is approximately 1,600,000 cu yd. A number of the alternatives have sufficient capacity to accommodate the entire dredging volume without use and development of multiple alternatives, providing material deemed suitable for ocean disposal is not placed with the unsuitable material.

Recommendations for Phase II Activities

Phase II activities for the LTMS process are associated with the formulation of appropriate alternatives. Specific engineering and environmental studies should be conducted for upland disposal as presented in Table 10. In addition, additional investigations should be conducted on the viability of the beneficial use alternatives. Based on the results of this Phase I effort, the following specific activities are recommended for Phase II:

a. Determine environmental, engineering, and economic criteria for dredging and disposal in an upland environment at Waipio Peninsula and the Reef Runway. Engineering criteria would include those on operational limitations on dredging equipment (pumping/haul distances), physical behavior of dredged material at disposal sites, and potential for contaminant transport.

b. Perform appropriate environmental and engineering studies necessary to evaluate the preferred, viable dredging and disposal alternative(s) (outlined in Table 10). The evaluation procedures are listed in Table 10 by pathway, test or task, along with their time and funding requirements.

c. Obtain additional data on sediment and water samples. Assess dredging characteristics and disposal needs, cultural/historic resource data based upon identified management options, and data related to dredged material physical properties for evaluation of range of environmental alternatives, beneficial uses, or other options. Conduct site studies for hydraulic analyses, upland, surface and groundwater evaluations, and environmental impact of dredged material disposal. Testing requirements for dredged material evaluation should be consistent with the CE's Regulatory Guidance Letter dated 19 August 1987. (U.S. Army Corps of Engineers Regulatory Guidance Letter, subject: Testing

Requirements for Dredged Material Evaluations, dated 19 August 1987 and signed by BG Peter Offringa, Deputy Director of Civil Works.)

d. Determine an appropriate forum and a central point of contact for coordination of the LTMS process with appropriate resource agencies and local interest groups. Solicit their comments on the results of the Phase I effort, and identify any additional concerns related to proposed dredging and disposal options. Incorporate, as appropriate, their substantiated concerns into the environmental standards.

e. Determine the need for further investigations such as sediment and water quality, hydraulic and sediment transport, and other areas of interest relative to selection of dredging methods, transportation systems, and disposal options. Prioritize the needs based on value to project and costs.

TABLE 10. PHASE II TESTING RECOMMENDATIONS

Test	Method	Disposal Alternative	Duration	Cost
Effluent	Flocculent settling test and modified elutriate test.	Upland, Nearshore	2 months	$20K
Runoff	Simplified runoff extraction test.	Upland, Nearshore	3 months	$40K
Leachate	HELPQ and RAAS screening model predictions.	Upland, Nearshore	1 month	$18K
Volatilization	Thibodeaux screening model predictions.	Upland, Nearshore	1 month	$15K
Plant Uptake	DPTA extract test.	Upland, Nearshore	1 month	$10K
Sedimentation	Zone and compression settling tests.	All	1 month	$12K
Sediment Characterization	Atterberg limits, specific gravity, grain-size distribution, organic content, in situ moisture content, and bulk chemistry.	All	1 month	$15K
Consolidation	Self-weight and standard oedometer consolidation tests.	Upland, Nearshore	2 months	$18K
TCLP	EPA method for toxicity characteristics leaching procedure.	Upland Reuse	1 month	$10K
Odor	Odor screening and control testing.	Upland	2 months	$15K

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Appendix A - Site Background and Environmental Setting

Descriptions of the site location, site history and land use, environmental setting, and site conditions in this appendix are taken directly from Ogden Environmental (1996) and are presented here for purposes of completeness. The information presented is primarily based on information taken from the site management plan (SMP) for the PHNC (U.S. Navy 1995), an *Evaluation of Sediment Contamination in Pearl Harbor* (Grovhoug 1992), and observations noted during a site reconnaissance conducted in July 1994.

A.1 SITE LOCATION

Pearl Harbor is a large complex natural estuary and a major feature located on the south coast of Oahu in the Hawaiian Islands. A majority of Pearl Harbor lies within the PHNC. It is located in the southern portion of the Ewa Plain, approximately 5.8 mile (mi) northwest of downtown Honolulu. Pearl Harbor contains 2,024 hectares (ha) (8 square miles [sq mi]; 5,000 acres [ac]) of surface water area and 58 kilometers (km) (36 mi) of linear shoreline. Through the influence of drainage, the Pearl Harbor estuary is the receptacle for runoff from approximately 28,502 ha (110 sq mi; 70,400 ac) of upland habitat comprising the watershed for much of the southern portion of the island of Oahu.

A.2 SITE HISTORY AND LAND USE

The following subsections provide a brief history of the PHNC and a summary of background information on existing activities. Other activities on and adjacent to Pearl Harbor are also discussed.

A.2.1 HISTORY

Grovhoug (1992) provides the following brief history of the PHNC. The PHNC has existed for nearly a hundred years and has undergone extensive changes since the mid-1800s when "Pu'uloa" (as Pearl Harbor was known by the ancient Hawaiians) was a large natural inland lagoon. Numerous walled fishponds located inside the harbor were used to cultivate various species of fish until the 1890s.

As one of the finest natural harbors in the Pacific Basin, Pearl Harbor was readily identified as a strategically important military asset. The U.S. Navy acquired rights to the harbor in an agreement with King David Kalakaua in 1873 (U.S. Department of the Interior 1969). After 1898, when Hawaii became a territory of the United States, plans were developed to dredge the harbor entrance channel and construct docking facilities inside the harbor. In 1901, the U.S. Navy acquired 800 acres (ac) of land to establish a Naval Station on Pearl Harbor (U.S. Navy 1983). The first major dredging of the entrance channel began in 1908, followed by construction of the first drydock in Hawaii at the Pearl Harbor Navy Yard (Nystedt 1977). After problems were encountered with underground water pressure, Dry Dock #1 was finally completed in 1919 (U.S. Navy 1983).

During World War I, a dozen warships were repaired and overhauled at the Navy Yard. From 1917 to 1918, a temporary submarine base was relocated from Magazine Island (Kuahua Island) to Quarry Point on the eastern shoreline of Southeast Loch. A naval ammunition depot was commissioned in 1919 at Magazine Island. Around 1920, many walled fishponds still remained intact.

During the 1920s and 1930s, shore facility developments continued and additional land was acquired by the Navy. Ford Island (formerly known as Moku'ume'ume, "island of the little goats") became a naval air station in the early 1920s. Work began on concrete moorings along the south side of Ford Island, which later became known as "Battleship Row." Industrial development was greatly accelerated in the Pearl Harbor area during the late 1930s and early 1940s. A considerable amount of acreage in the Pearl Harbor Naval Complex has been created since 1930 by the deposition of dredge spoil materials (U.S. Navy 1947).

On 7 December 1941, the Japanese imperial Navy launched a surprise air attack on the U.S. Fleet in Pearl Harbor from a task force of 32 vessels, including 6 aircraft carriers with 350 warplanes. This attack sank or severely damaged 21 of the 86 U.S. Navy warships in Pearl Harbor (Lenihan 1989; U.S. Navy 1989a). Chemical evidence (i.e., elevated concentrations of copper, lead, and zinc) of this period remains detectable in buried Middle Loch sediments that have not been disturbed by dredging activities (Ashwood and Olsen 1988). They also report that the bombing attack resulted in about six times more lead input to this estuarine area than the total combined lead input from sewage disposal and naval maintenance operations during the succeeding 45 years.

From 1940 to 1943, large amounts of dredged material were placed on Waipio Peninsula and areas adjacent to the Submarine Base (U.S. Navy 1983). These landfill operations formed the present shoreline configuration of the inner harbor. From 1942 to 1944, the number of facilities and personnel at the PHNC increased greatly to support the war in the Pacific. Storage facilities for ordnance and material filled nearly all available land regions near Pearl Harbor.

By mid-1943, civilian employment at the Navy Yard rose to 24,000 personnel (U.S. Navy 1983).

After World War II and throughout the late 1940s, the number of service personnel and active facilities at Pearl Harbor decreased markedly. During the Korean War and the Vietnam conflict, operations and support personnel at the PHNC increased in response to the nation's defense requirements, but never to the same extent as during World War II. Today, Pearl Harbor is a major fleet Homeport for nearly 40 warships; service force; vessels and submarines; and associated support, training, and repair facilities. The region is also listed as a National Historic Landmark.

A.2.2 Present Activities on Pearl Harbor

During the last century, many human activities have been concentrated along the shoreline and within the upland drainage basins that empty into the harbor. These activities include the industrial and operational activities of the U.S. Navy; private industrial operations; municipal, commercial, and urban activities; and agriculture. These activities potentially release numerous types of chemical contaminants into the air, water, and soil along the shoreline and within the drainage basins that empty into Pearl Harbor. The approximately 2,024 hectares (ha) (5,000 ac) of soft (e.g., mud and sand) sediments comprising the bottom in Pearl Harbor are the ultimate sink or repository for these chemicals and the natural habitat for thousands of estuarine and marine species.

A.2.2.1 Present Day PHNC

The present day PHNC is an outgrowth of more than 100 years of peacetime and wartime development that has resulted in (1) dredging to construct a channel and berthing area of sufficient depth to allow passage of the "largest of ships" (Grovhoug 1992) and (2) construction of extensive shoreside facilities (e.g., ship mooring and repair facilities, fuel storage, handling, transfer, and recycling facilities as well as operations, maintenance, and support facilities) to meet changing needs of the U.S. Fleet. Military vessels using the harbor on a regular basis include U.S. Navy surface ships, submarines and harbor craft; U.S. Army cargo transport vessels; U.S. Coast Guard buoy tenders and patrol vessels; and foreign naval vessels. Harbor navigation channels and mooring areas at piers and wharves supporting these vessels are maintained at water depths necessary for safe navigation through a program of routine maintenance dredging. New facilities are developed as needed and may involve in-water construction and project specific dredging. This development has evolved into six major activities (military and civilian operations) at the PHNC. The location of each activity is shown in Figure A1 and described as follows.

A.2.2.1.1 Naval Station (NAVSTA), Pearl Harbor

NAVSTA Pearl Harbor controls the waters of Pearl Harbor as well as many noncontiguous and submerged lands in and around the harbor. The total land area consists of approximately 336 ha (830 ac), whereas submerged land includes another 2,008 ha (4,960 ac). NAVSTA includes the main base area, Ford Island, and outlying facilities at Richardson Recreation Center/Pearl Harbor Memorial Park, Makalapa Crater, Bishop Point, Waipio Point, Beckoning Point, and the Aiea Laundry. The main base includes ship berthing facilities, the core area with barracks and community support facilities, Marine Barracks, the Shore Intermediate Maintenance Activity (SIMA) area, and the NAVSTA Pearl Harbor service craft area located in Magazine Loch and around Kuahua Peninsula (PACNAVFACENGCOM 1992).

A.2.2.1.2 Naval Submarine Base (SUBASE), Pearl Harbor

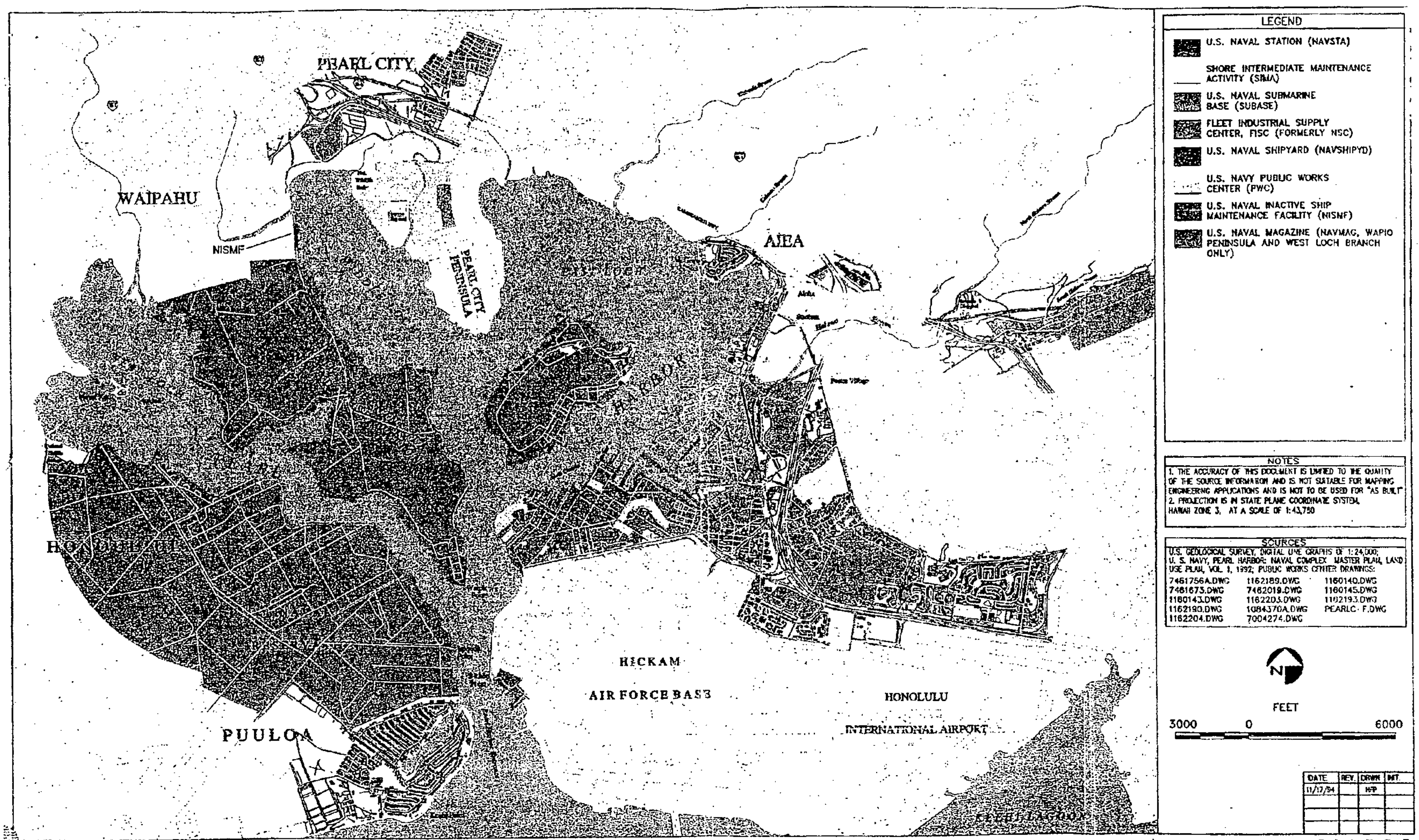
The SUBASE area occupies 50 ha (123.5 ac) of land that provides berthing and shoreside facilities for submarines in port, along with submarine maintenance and training facilities.

A.2.2.1.3 Fleet and Industrial Supply Center (FISC), Pearl Harbor

FISC Pearl Harbor (formerly referred to as Naval Supply Center, or NSC) is located in six noncontiguous areas that occupy approximately 324 ha (800 ac) of land. FISC provides supply and logistic support services to fleet units and naval shore activities. It serves as the single water terminal clearance authority for traffic management and ocean terminal services, and it also maintains the largest bulk fuel storage facility in the Pacific area. FISC controls the Red Hill Fuel Storage Facility, Pearl City Peninsula, Manana Storage Area, Pearl City Junction, and the Ewa Junction Fuel Drumming Facility and Storage Area. In addition, it controls the Upper, Middle, and Lower Tank Farms at the PHNC.

A.2.2.1.4 Naval Shipyard (NAVSHIPYD), Pearl Harbor

NAVSHIPYD Pearl Harbor is located within the main base on approximately 64 ha (159 ac) of land where it functions as a major ship



NAVAL ACTIVITIES
PEARL HARBOR NAVAL COMPLEX
OAHU, HAWAII

FIGURE 2-1

Figure A1. Naval activities, Pearl Harbor Naval Complex, Oahu, Hawaii repair and overhaul facility. The maintenance operation includes industrial shops, quality control testing laboratory, and engineering and administrative offices.

A.2.2.1.5 Navy Public Works Center (PWC), Pearl Harbor

PWC Pearl Harbor maintains Navy family housing units and utilities systems. It also provides public works, transportation support, engineering services, and shore facilities planning support. The main PWC complex is located on 28.7 ha (71 ac) of land approximately 1 mile east of the main entrance to the PHNC.

A.2.2.1.6 Naval Magazine (NAVMAG), Pearl Harbor

The NAVMAG Lualualei is located on the island of Oahu where it was established as a tri-service facility providing ordnance support to the Navy, Air Force, and Army. It consists of three noncontiguous branches of which the West Loch Branch is the only facility located within the PHNC as defined in the Federal Facilities Agreement (FFA; U.S. Navy 1994). The West Loch Branch is located adjacent to the West Loch of Pearl Harbor and covers an area of approximately 1,657 ha (4,092 ac), including approximately 577 ha (1,425 ac) at Waipio Peninsula. This facility is a Department of Defense (DoD) ordnance storage facility with magazines, operating buildings, community and personnel support facilities, and wharves for loading and off-loading ordnance.

In addition to these six centers of naval activity, the Naval Sea Systems Command Detachment (NAVSEADET)/Naval Inactive Ship Maintenance Facility (NISMF) is also an integral part of the PHNC. NISMF Pearl Harbor is located on a narrow strip of land, approximately 5.7 ha (14 acre) in size, along the northwest shoreline of Middle Loch, and the water area in the upper portion of the Loch where several "mothballed" ships are moored. Approximately 2 ac of the site have been developed for maintenance operations.

<u>A.2.2.2 Other Activities on and Adjacent to Pearl Harbor</u>

Similar to the present day PHNC, the urban and rural areas in the vicinity of Pearl Harbor (including Honolulu and its suburbs) encompass and reflect more than 100 years of peacetime and wartime development. Over this time period, land use in private and public areas adjacent to the harbor has shifted from primarily agricultural (including sugar cane, pineapple, taro, and watercress farming) to commercial, industrial, and residential activities. For example, a marked increase in urban development on leeward Oahu is reflected in recent extensive housing development in the Pearlridge, Waimalu, and Waiawa areas of Pearl City since 1970. The Waipahu and Ewa Beach regions have experienced greatly increased residential growth in recent years. Commercial and light industrial complexes have accompanied this growth. The sum of these past and present-day activities have resulted in mixed land uses including various light industrial, municipal, commercial, urban, and agricultural activities. These activities have the potential to contribute broad ranges of chemicals to the Pearl Harbor estuary and its associated sediments.

Chemical contaminants may be transported to the harbor from these upland activities through natural and man-made transport pathways (e.g., urban runoff, airborne particulates, ground water intrusion, etc.; see Section A.3 for a more detailed discussion). Nonpoint as well as point-source runoff of surface water (e.g., from storm drains and streams) can provide inputs for diverse chemicals from activities such as highway/surface street operations and maintenance, leachings from asphalt and concrete surfaces, automotive vehicle-related residues and emissions (e.g., metals, petrochemicals, oils, and lubricants), and urban/suburban-derived pesticide and herbicide spray operations and usages.

Other more localized, although numerous and therefore widely dispersed, point sources of chemicals include activities such as machining and metalworking operations (sources for items such as metals, cutting oils, degreasers, and hydraulic fluids) as well as the variety of repair, maintenance, and fueling operations (including gas stations) associated with the automotive and trucking industries. The latter activities can be sources for fuels, lubricants, and general emissions as well as less obvious contaminant sources such as bearings, automotive finishes, thinners and solvents, batteries, brake fluid, brake linings, catalytic converters, degreasers, hydraulic fluids, etc.

Additional land- and air-based transportation operations that can serve as direct and/or indirect sources for chemicals include activities at commercial airports (e.g., Honolulu International Airport) as well as railroad lines in the vicinity of the harbor. Commercial establishments providing cleaning or laundry services can be sources for general and dry cleaning fluids (including Stoddard solvent), degreasers, fumigants, and various pesticides.

Agricultural practices and related activities (including sugar refining operations) and golf courses, which exist at numerous locations in the vicinity of the harbor, are likely major sources not only for diverse mixtures of pesticides and herbicides but also activity-related chemicals (e.g., metals, petrochemicals, fuels, and solvents).

Common public-support facilities such as fire stations can be sources for contaminants such as petrochemicals (e.g., fuels), oils, lubricants, solvents, and degreasers. Other public-support facilities such as electrical power facilities and associated operations can be sources for polychlorinated biphenyls (PCBs) (e.g., from transformers), petrochemicals (e.g., from bulk storage facilities for fuels) and metals from cooling water discharges.

Finally, landfills (e.g., the City/County landfill at the head of West Loch) can be sources for myriad chemicals (e.g., metals, pesticides and herbicides, oils, petrochemicals, PCBs, and dioxin) disposed of in the facilities that then gain entry to receiving waters in Pearl Harbor through routes such as incineration and burning operations, surface and sheet runoff, and ground-water flow.

On-water operations in Pearl Harbor that can contribute chemicals to the sediments include commercial freighters and tankers, commercial tour craft, commercial fishing vessels (to collect baitfish), and recreational vessels (e.g., sailboats and motorized vessels). In addition to these vessel-related operations, marinas can be sources for chemicals as well. The Rainbow Bay Marina, located in the east-northeastern region of the harbor, is a recreational small-boat moorage facility with a capacity of approximately 70 small vessels. The Iroquois Point Lagoon Marina, located through a narrow inlet along the western side of the harbor's entrance channel north of Iroquois Point, has a capacity of approximately 45 small vessels. These marinas represent the only pleasure-boat moorage facilities in Pearl Harbor.

A.3 ENVIRONMENTAL SETTING

Grovhoug (1992) reviewed past environmental information on Pearl Harbor compiled from numerous studies conducted over several years. The majority of these studies are project specific and address environmental concerns at specific locations in the harbor. Some studies were spatially comprehensive providing data for large areas of the harbor (e.g., the IAS study of historic contamination, the Evans et al. 1974 assessment of biological and physical conditions in the harbor, and the Youngberg 1973a study of metals in the harbor). In general, these studies provide useful background information but are limited for purposes of a harborwide assessment by age (e.g., some are 20 years old), fragmented over temporal and/or spatial scales, provide data on only a limited number of the COPCs (e.g., metals), provide no direct measurement of effects of chemicals, and/or were conducted to meet specific objectives different from those addressed in this study. More recent studies addressing the suitability of dredge material for ocean disposal provide data on toxicity and sediment chemistry. However, these measurements also have limited usefulness for the purposes of this study because they do not address many of the potential chemicals of concern, are based on measurements made on composites of multiple core samples several ft long, are very site specific, and focus on limited areas of the harbor where dredging is necessary. Despite these limitations, results of investigations summarized by Grovhoug (1992) provide basic background information for this project and, where appropriate, support the design of the study described in subsequent sections of this WP.

This proposed study will provide a current synoptic set of data specifically designed to characterize sediment contamination throughout the full extent of Pearl Harbor, evaluate the potential risk of contaminated sediments to human health and the environment, and identify areas that may require remediation.

This section includes a summary of the upland environment (Section A.3.1), the marine and wetland environment (Section A.3.2), and critical environments (Section A.3.3) within Pearl Harbor. An understanding of the upland environment around Pearl Harbor is relevant to this investigation of harbor sediments because these sediments are a major sink or repository for chemicals that may have been transported to the harbor from upland activities through natural and man-made transport pathways.

A.3.1 Upland Environment

The upland environment includes site topography, geography and geology, soil characteristics, surface water, ground water, climatology, and land use.

A.3.1.1 Topography

The topography of Oahu consists of two nearly parallel mountain ranges, the Waianaes and Koolaus, trending northwest to southeast and separated by the Schofield Plateau. A large, relatively flat, gently sloping coastal plain borders the plateau from the south. The PHNC lies primarily within this coastal plain. Nearly all of Ford Island and the Pearl City Peninsula are low-lying, where ground elevations are less than 6.1 meters (m) (20 ft [ft]) above mean sea level (MSL). The eastern portion of the PHNC has a maximum elevation of 24.4 m (80 ft) above MSL at the rim of Makalapa Crater. From this location, it slopes gently toward sea level at East Loch. In the western portion of the PHNC, ground elevations range from approximately 3 to 30.5 m (10 to 100 ft) above MSL, and the surface slopes south toward Hickam Air Force Base and Honolulu International Airport.

A.3.1.2 Geography and Geology

The Hawaiian Islands are eroded tops of large shield volcanoes that rose from the ocean floor. Each of the islands consists of one or more volcanic domes composed primarily of thin, permeable basaltic lava flows. The island of Oahu comprises two major volcanic mountain ranges, the Koolau range on the east and the Waianae range on the west. Both of these ranges are the remnants of large, elongated shield volcanoes that have lost most of their original shield outlines and are now long, narrow ridges shaped by erosion.

East of Pearl Harbor lies a cluster of overlapping volcanic turf cones comprising the Honolulu Volcanic series. These include the Aliamanu, Salt Lake, and Makalapa Craters, with Aliamanu being the oldest and Makalapa being the closest to the PHNC.

Pearl Harbor is essentially a series of drowned river valleys. After the formation of the Koolau and Waianae volcanoes, Pearl Harbor formed on the southern coast of Oahu through a history of rising and falling sea levels, subsequent erosion and deposition of alluvial material, and pyroclastic deposition of ash from eruptions at the Salt Lake and Makalapa Craters.

Pearl Harbor consists of three lochs (West Loch, Middle Loch, and East Loch) that join to form a single channel entrance. The west side of the harbor is composed mostly of limestone reef material known as the Ewa Plain. The east side of the harbor consists mainly of volcanic tuff. To the north, volcanic basalt forms the bulk of rock material. Marine and terrestrial sediments occur around the perimeter of the harbor.

A.3.1.3 Soil Characteristics

The soils within the Pearl Harbor Basin include several different soil associations. According to the United States Department of Agriculture (USDA), the majority of U.S. lands within Pearl Harbor are comprised of the Lualualei-Fill Land-Ewa association (USDA 1972). These soils are well drained, fine to moderately fine textured, and typically occur on fans and drainage ways on the southern and western coastal plains of Oahu. The soils are formed in alluvium and are nearly level to moderately sloping. This soil association makes up approximately 14 percent of the island of Oahu.

The specific soil material underlying the PHNC is primarily fill, consisting of a mixture of fine-grained dredge-fill sediments, clays, silts, sands, and coral, and basalt gravels and cobbles.

A.3.1.4 Surface Water

Pearl Harbor is an estuarine environment, bordered by wetland, marsh, and swamp habitat where siltation is a significant process.

Pearl Harbor receives surface water runoff from seven watersheds: the Waikele, Waiawa, Waimalu, Aiea, Halawa, Honouliuli, and Ewa Beach watersheds. The Waikele watershed is the largest, comprising approximately 40 percent of the Pearl Harbor Basin. It is drained primarily by the Waikele Stream, which discharges the heaviest sediment load of any of the Pearl Harbor Basin streams (Grovhoug 1992).

Of the eight streams discharging into Pearl Harbor, five are perennial (Waikele, Waiawa, Waimalu, Kalauao, and Halawa) and three are intermittent (Aiea, Honouliuli, Waiau (Waimano). The perennial streams have headwaters in the high-rainfall forest-reserve region of the Koolau Range. All streams drain forested and agricultural lands and pass through highly urban areas before entering Pearl Harbor.

Surface water collected along the southern portion of the PHNC drains across the Honolulu International Airport, Hickam Air Force Base, and Fort Kamehameha Military Reservation before entering the Pacific Ocean.

The volume of freshwater entering Pearl Harbor has been estimated at 50 million gallons per day (MGD) during dry periods and greater than 100 MGD during rainy periods (Cox and Gordon 1970; B-K Dynamics 1972). The total drainage area for Pearl Harbor is estimated to be 28,502 ha (110 sq mi; 70,400 ac). Siltation rates are highest in Middle and West Lochs, which both receive larger stream flows than East Loch.

A.3.1.5 Ground Water

The movement of ground water is controlled by local hydrologic conditions that influence the supply and distribution of water (Youngberg 1973b). The Pearl Harbor area has both sedimentary caprock aquifers and basaltic aquifers. Sedimentary caprock lies atop an unconfined aquifer in which water moves downward to the zone of saturation (water table). The caprock is underlain by an impermeable stratum that overlies and confines the basaltic aquifer. The Koolau basalt aquifer is still artesian in the Pearl Harbor area (U.S. Navy 1983). Area installations are underlain by a shallow water table. Ground-water migration is generally towards Pearl Harbor or the Pacific Ocean with additional recharge being generated by rainfall, stream infiltration, and return irrigation waters in the middle and lower elevations. In the northern Pearl Harbor area, ground-water discharge supports perennial stream flows and springs, but farther to the south, water in the basalt aquifer is trapped by the confining layers of the coastal plain caprock, creating an artesian condition.

Ground-water flow toward the harbor may act as a transport pathway for contaminants present in upland soils to reach Pearl Harbor. Contaminants present in upland soils may enter the ground water by leaching through highly permeable overlying soils except in areas overlain by sedimentary caprock. Once in the ground water, contaminants may be transported to the harbor.

A.3.1.6. Climatology

Mean annual rainfall in the vicinity of the PHNC is approximately 64.8 centimeters (cm) (25.5 inches). The PHNC is relatively dry when compared with other areas on Oahu, particularly just leeward of the crest of the Koolau Range where mean annual rainfall may exceed 275 inches. Rainfall is seasonal, varying from 10.2 cm (4 inches) per month during the winter (December to February) to 2.54 cm (1 inch) per month during the summer (June to July) (Giambelluca et al. 1986).

The prevalent winds across the PHNC are the northeast trade winds that prevail for approximately 9 months of the year. The mean wind speed is 11.6 miles per hour (mph). During the balance of the year, south to southeast winds and mild offshore breezes prevail. The south winds are usually accompanied by wet tropical air and frequent showers. During the summer months, periods of "no wind" occasionally occur but do not persist for more than a few days.

Temperature varies considerably by season as well as diurnally in the Pearl Harbor region. During the summer months, afternoon high temperatures range between 30.5 and 31.6 degrees Celsius (°C) (87 and 89 degrees Fahrenheit [°F], and nighttime low temperatures range between 22.2 and 24.4 °C (72 and 76 °F). In the winter months afternoon high temperatures range from 24.4 to 25.5 °C (76 and 78 °F) with nighttime low temperatures ranging from 12.8 to 18.3 °C (55 to 65 °F).

A.3.1.7 Land Use

Land use within PHNC is primarily limited to operational and industrial activities; unaccompanied personnel housing; and related administrative, training, and support facilities (U.S. Navy 1984). Encroachment issues for the operational areas of Pearl Harbor are minimized because the military controls all the harbor waters and most of the harbor shoreline.

Land use in private or public areas adjacent to Pearl Harbor has shifted from primarily agricultural (including sugar cane, pineapple, taro, and watercress farming) to commercial, industrial, and residential. A marked increase in urban development on leeward Oahu is reflected by recent extensive housing development in the Pearlridge, Waimalu, and Waiawa areas of Pearl City since 1970. Waipahu and Ewa Beach regions have experienced greatly increased residential growth in the past few years. Commercial or light industrial complexes have also accompanied this growth. The construction of the Honolulu International Airport reef runway during 1973 through 1977 required extensive land-filling activities (an estimated 19 million cubic yards [yd^3] of dredged material), which modified water circulation patterns and the marine habitat near the harbor entrance channel (AECOS 1979).

A.3.2 Marine Environment

Pearl Harbor contains approximately 2,024 ha (5,000 ac) of soft-bottom (e.g., mud and sand) benthic or harbor bottom habitat. Although specific species in the benthic community may change with water depth and location in the harbor, the major biotic components in the community generally include infaunal organisms that burrow and live in sediments (e.g., amphipods, worms, clams, snails, and shrimp) and epifauna that lives on or in proximity to the sediment surface (e.g., crabs, snails, and bottom fish). These benthic organisms are a major link between the primary producers and the upper trophic levels of the harbor food web. In particular, the benthic invertebrates are a major food source to other benthic species (e.g., fish and crabs consume epifaunal and infaunal invertebrates, etc.) that may ultimately be consumed by humans. The benthic community also provides a food source to primarily terrestrial species such as shorebirds (e.g., stilts) and diving ducks that may forage on intertidal mudflats and in shallow waters.

Estuaries are important habitats because of their generally high productivity; their use as nursery and rearing areas by numerous birds, motile fish, and crustacean species; and the ability of these motile species to export the energy fixed in the estuary to other (terrestrial and offshore) environments (e.g., Deegan 1993; McClintock et al. 1993). The Pearl Harbor estuary supports the types of organisms that produce these benefits (e.g., nehu and other fish and portunid crabs such as *Thalamita)* and the fishes observed in the estuary appear to be dominated by juvenile year classes (Evans et al. 1974; Grovhoug 1992). Because of its relatively large size, the Pearl Harbor estuary comprises a significant proportion of the estuarine habitat in the main Hawaiian Islands. It is therefore important to protect its biological productivity and its functionality as a rearing and nursery area for a variety of important fish and indigenous bird species.

Grovhoug (1992) summarized past biological investigations on Pearl Harbor and reported the harbor is characterized by high biological complexity and productivity for plankton, fouling, benthic, and fish assemblages. During comprehensive field studies conducted by Evans et al. (1974) more than 90 species of marine fishes, 114 species of benthic organisms, 71 species of micromollusks, and 88 species of piling organisms were identified from the harbor ecosystem. The estuary provides important nursery areas for many marine fish species and remains an economically important location for the Hawaiian anchovy (nehu) bait fishery.

A.3.3 Critical Environments

Several wetland areas are located adjacent to Pearl Harbor in East Loch, Middle Loch, West Loch, and on the Waipio Peninsula. The Pearl Harbor

National Wildlife Refuge has two units located at Honouliuli in West Loch and at Waiawa on Pearl City Peninsula (State of Hawaii 1979). These areas are known habitats for several endemic and endangered waterbird species, including the Hawaiian stilt, "A'eo" *(Himantopus knudseni),* the Hawaiian coot, "Alae Ke'oke'o" *(Fulica americana alai),* the Hawaiian duck, "Koloa" *(Anas wyvilliana),* and the Hawaiian gallinule, "Alae 'ula" *(Gallinula chloropus sandvicensis) (U.S.* Navy 1982 and 1989b). The endemic Hawaiian or Short-eared Owl, "Pu'eo" *(Asio flammeus sandwichensis),* also hunts in the area. This owl is very rare on Oahu and has been listed as endangered by the State of Hawaii (U.S. Navy 1989b).

Hawaii has the largest number of threatened or endangered species of any state in the United States. The pressures on the indigenous flora and fauna are intense. Several of these species are limited in their distribution to wetland and estuarine habitats (e.g., Hawaiian coot, Hawaiian stilt, and Hawaiian duck). The survival of these species is heavily dependent upon both the nesting and rearing areas and the benthic food items available in these habitats. Pearl Harbor is one of the largest estuaries in Hawaii and is therefore extremely important to the preservation of these species.

Quiet waters in the upper regions of all major Pearl Harbor lochs provide excellent habitats for the Hawaiian anchovy, "nehu" *(Encrasicholina purpurea),* a species harvested as a baitfish in the offshore tuna, "aku," fishery. This species is the most important baitfish resource in Hawaii, and Pearl Harbor provides a primary harvesting area in the state (Grovhoug 1979). Several natural marine resources in the Pearl Harbor estuary are harvested by local residents for consumption (e.g., goatfish, mullet, crabs, oysters, and algae) (personal communication with J.G. Grovhoug 1995).

Fish and wildlife resources on lands and waters within the PHNC are managed under a cooperative agreement among the U.S. Navy, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Services, and Hawaii State Department of Land and Natural Resources (U.S. Navy 1993)

A.4 SITE CONDITIONS AND ENVIRONMENTAL ACTIVITIES

Over the past 11 years, the Navy has actively undertaken a program to identify, characterize, evaluate, and address contaminated sites within the PHNC. As a result of these activities, many sites within the PHNC have been identified, characterized, and in some cases, remediated. A preliminary assessment of the PHNC, referred to as the IAS, was conducted by NEESA in 1983 (Initial Assessment Study of Pearl Harbor Naval Base, Oahu, Hawaii, NEESA 13-002 [NEESA 1983a] and Initial Assessment Study of Navy Installations on Oahu, Hawaii: NAVMAG Lualualei, NEESA 13-047 [NEESA 1983b]). In addition to the IAS, USEPA conducted a RFA of the more highly industrialized areas located within the PHNC in 1987. Many of the sites identified, as a result of these studies, were believed to pose little or no threat to human health and/or the environment. As a result, these sites have been recommended for no further response action planned (NFRAP) status. The remaining sites were recommended for further response action to address suspected or confirmed site contamination. Although recommendations related to many of the PHNC sites have been presented previously, USEPA requested that PACNAVFACENGCOM conduct an evaluation of the historical environmental information related to the PHNC due to the relatively long period of time since these studies were conducted. The complete results of this evaluation are presented in PHNC SMP (U.S. Navy 1995).

The SMP identifies active RI sites and sites recommended for no further response action. Although the SMP evaluation focused on upland areas and not harbor sediment, the information is relevant to this investigation. First, harbor sediments are a major sink for chemicals that may have been released in upland areas and transported to the harbor through natural and man-made transport pathways (e.g., surface water flow of storm water runoff via streams and/or storm drains, ground water intrusion, spills, airborne particulates, etc.). Although most of these sites have and/or had the potential to contribute chemical contaminants to the harbor, especially before source controls and Best Management Practices were established, those sites actually on the water (e.g., shipyards, fueling operations, landfills, etc.) are probably the most important contributors.

Figure A2 presents the location of each of the active sites where additional investigations are or will be conducted. The ongoing investigations at these sites have deferred issues associated with sediment contamination from the site to this study. Accordingly, samples are designated at these locations to address any contamination potentially originating from these sites that is presently resident in harbor sediments.

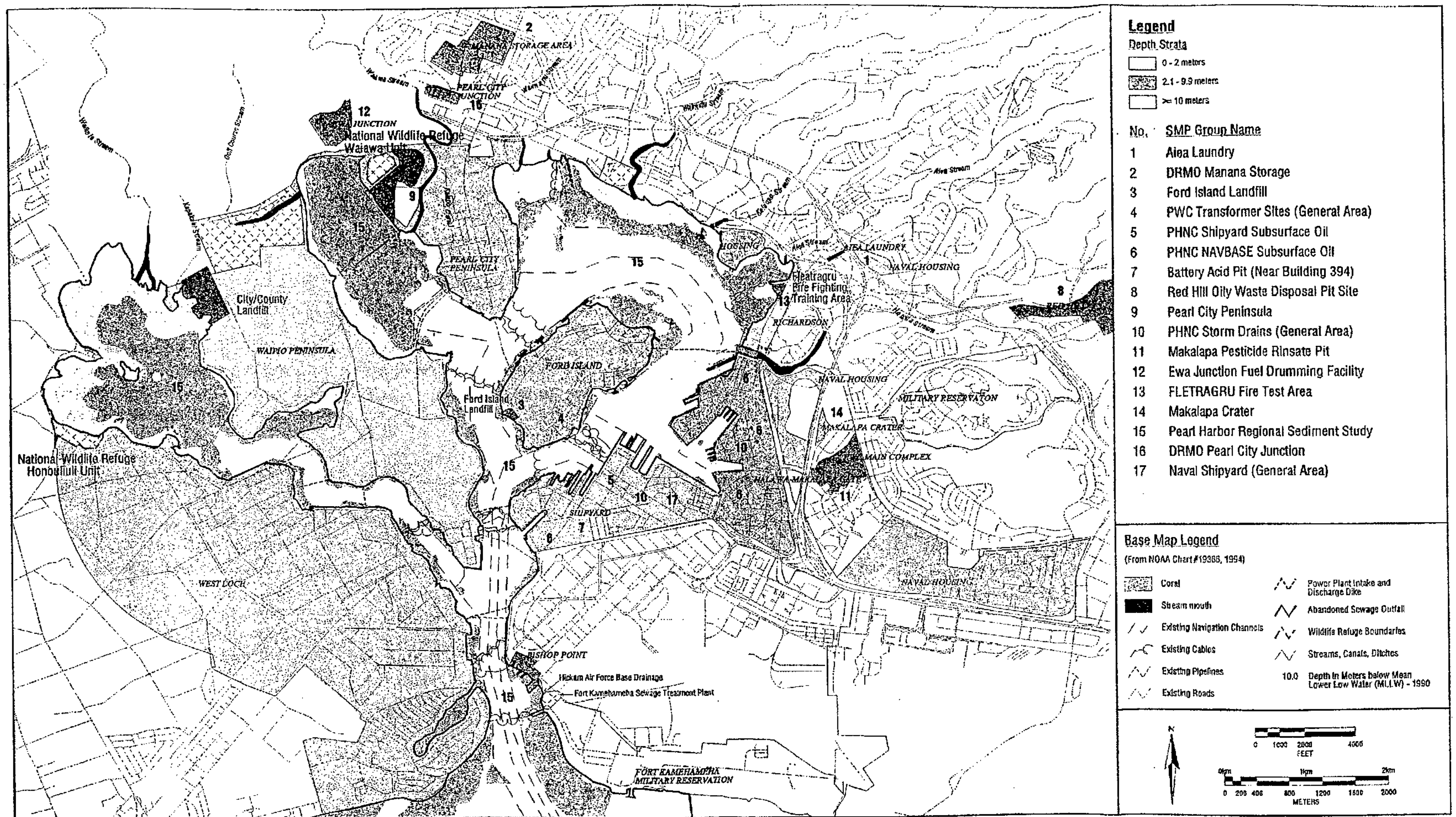


FIGURE 2-2

SITE MANAGEMENT PLAN IR SITES

Figure A2. Site management plan IR sites

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Appendix B - Planning Level Cost Estimates of Proposed Dredged Material Disposal Alternatives for Pearl Harbor LTMS

Assumptions for All Scenarios

Unless otherwise noted, estimates are based on disposal of 300,000 cubic yards (gross volume) of sandy silty dredged material. No consideration for material expansion (fluff factor) was applied nor any costs associated with handling and disposal of trash and debris. The type of dredging plant is a locally available 7-cubic-yard clamshell derrick barge. Also assumed to be locally available are various types and capacity material barges, land equipment, material handling and slurry pumping systems. The level of contamination is such that: decontamination of equipment is not required; treatment of effluent requires no more than ponding and mechanical (absorbent) filtering; loading of material transport barges can be done in such a manner as to allow for maximum percent solids. All floating plant and vessel positioning requirements will be accomplished by differential global positioning system (DGPS) with sub-meter accuracy. Bidding will be unrestricted, full and open competition. No estimated contingency for work delays resulting from vessel traffic, poor weather, or high sea conditions was considered. Estimates do not include profit. Printouts of the spreadsheets giving the details of the cost estimating for the scenarios are presented at the end of this appendix.

Scenario 1. East Loch Capped CAD Facility

Disposal Strategy

Dispose of dredged material by dumping and capping within an in-water facility of sufficient capacity to meet a 30-year requirement.

Assumptions

Material to be excavated in association with the preparation of the in-water site will be as dredgable as the material encountered at the primary dredging site(s).

Site Parameters, Available Area

The site is an area approximately 1000 ft in diameter within an ammunition anchorage area. This shape will provide the required 30-year capacity of 1,600,000 cubic yards at an assumed excavated depth of 50 feet with inside slopes of 2 feet horizontal run for every foot of depth.

Site Parameters, Estimate Configuration

For estimating purposes, the disposal area was configured as a rectangle, 1000 ft on a side and subsequently divided into three equal lanes measuring 333 ft wide by 1000 ft long with 1-on-2 interior slopes. The subdivision of the overall site into three 333-ft wide lanes provides flexibility concerning the amount of effort and expense associated with site utilization over a long period of time. Staged preparation of the overall site will decrease capacity loss due to natural infill and reduce the cost of dredging and placement of capping material since a significant portion of the cap material could be obtained by excavation of an adjacent lane which would in turn reduce the preparation effort for subsequent site preparation work. Consequently, the initial disposal operation will require material to be removed from the first lane to provide disposal capacity. Capping material for lane one will be obtained from lane two which will reduce the cost of site preparation for lanes two and three. However, capping material for lane three will probably have to be brought in from offsite. This estimate is based on the initial disposal operation and assumes lane one will be dredged and the excavated material disposed offshore. Each lane would provide 533,000 cubic yards of capacity for disposal of dredged material covered with an additional 4- to 5-ft cap.

Excavation of the East Loch In-water Disposal Site

The estimate is based on a 7-cubic-yard clamshell dredge operating 24 hours per day (three 8-hour shifts), seven days per week (assuming 15% downtime). Conversations with a local dredging contractor indicate that this capacity bucket dredge is currently available. An operating crew will consist of an Operator, Engineer/Oiler, and Deckhand/Boat Operator. Horizontal control will be accomplished by a boom tip mounted single receiver DGPS system which will interrogate the USCG "Starlink" differential GPS broadcast. Vertical control will be provided by a real time automated tide gage monitoring and broadcast system. The dredge tender/crew boat will be available at the work site to provide dredge propulsion and service transport as needed. The tender will be operated by dredge deck crew.

Disposal Logistics

East Loch Disposal Site Excavation. Material excavated from the East Loch in-water site will be transported to the Oahu ocean disposal area, approximately a 7.3-nautical mile one-way haul, using two 3000-cubic-yard dump barges cycled by a single 2000-hp tug. Tug service will be sub-contracted with payment made on a load basis. Standard navigation level GPS would be the minimum standard required to insure proper disposal of material within the limits of the ocean site.

Placement and Capping of Dredged Material at the East Loch Site. Dredged material will be transported from various locations within Pearl Harbor, averaging a 3-mile one-way haul, using a single 3000-cubic-yard dump barge cycled by a 2000-hp tug. Short haul distance and sheltered marine conditions indicate a reduction in barging capacity and tug size from that employed to transport material to the Oahu offshore area. The same transport equipment will be used to transport and place the capping material excavated from within the overall East Loch disposal site or immediately adjacent areas. Disposal placement will be controlled by the DGPS system with receiving antennas located on both the bow and stern of the material barge. Tug service will be subcontracted with payment made on a load basis.

Major Cost Components for Scenario 1

Excavation and Disposal	$2,720,000.00
Capping	390,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost Scenario 1*	$5,550,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 2. Waipio Peninsula CDF

Disposal Strategy

Create confined upland disposal area of sufficient capacity to accommodate the anticipated volume of material to be disposed over a 30-year period without special considerations for dewatering or rehandling of material. Material will be transferred from material barges to the upland site by utilizing a reslurry pump-out system.

Assumptions

The existing ground within the boundaries of the Waipio site is relatively flat and is suitable to be used as dike construction material. The dike height will be 10 feet above original ground with a minimum top width of 12 feet. Side slopes will be 1 foot vertical on 2 feet horizontal. This estimate covers the expense to prepare the site for long-term placement of material (30 years), but the estimate to place dredged material is based on 300,000 gross cubic yards (the upper limit of the estimated annual disposal volume). The overall size of the site and the relatively small to moderate annual volume of disposal material is such that dewatering will occur through evaporation and ground leaching. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the off-loading of material barges. The expense of locating and maintaining existing underground utilities within the site area during disposal operations will be covered by increasing the standard contingency factor from 15% to 30%.

Site Parameters

The site is located on the seaward end of Waipio Peninsula which separates Pearl Harbor's West Loch and Middle Loch. The overall site plan incorporates areas designated as Area 1 (88 acres) and Area 2b (36 acres). Disposal Scenario 2 calls for the utilization of the entire 124 acres available, subdivided into two cells for flexibility in operating and managing the site. Based on an assumed dike vertical height of 10 feet and a maximum fill elevation of 6 feet, the proposed area would accommodate up to 1.6 million cubic yards if desiccated.

Disposal Site Preparation and Placement of Material

<u>Mobilize/Demobilize</u>. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material.

<u>Site Preparation</u>. Preparation of the site consists of clearing and grubbing the site and constructing a perimeter dike around the entire outer boundary of the 124-acre area. A typical dike cross section consists of a 52-foot-wide base, 1 foot vertical on 2 feet horizontal side slopes, capped with a compacted 12-foot-wide top that will provide vehicle access for maintenance and management operations. The site preparation estimate is based on employing three D8 class Caterpillar tractors to:

1. Establish a dike foundation "key" approximately 52 feet wide by 1.5 feet deep.

2. Construct 13,600 linear feet of perimeter dike, 10 feet high, by excavating ("pushing up") material from within the existing site boundaries in five 2-foot lifts. Each lift would be dry compacted by the tractors.

Material Disposal Operation. Material disposal includes mobilization/ demobilization of equipment, material barge transit between the dredging site and the unloader station (a reslurry and barge pump-out system), material transfer from barges to the confined upland site, and dispersal of material within the diked system. A discharge pipeline landing with splitter valve and 500 feet of shore pipe (12-inch-diameter plastic) is assembled and deployed by the shore crew to initiate placement of material with subsequent deployment of an additional 2,500 feet of shore pipe (two runs of 1250 feet along each of the east and west perimeter dikes in order to promote even dispersal of the material) during the progress of work. The unloader consists of a platform-mounted DSC BARACUDA 12-inch diameter pumping system, a 14,500-GPM Griffin upwater pump, and a 4100 class Manitowoc crawler crane all of which is staged on a 750-ton spud barge. The unloader barge is tended by a 25-foot tender/crew boat. The spud barge is positioned in useable water immediately adjacent to the shore pipe landing and connected to the floating pipe deployed by the unloader crew. The pumping platform is placed athwart the material barge by the attending crane. Transit of material barges between the dredging site and the off-loading station will be accomplished by subcontracting tug services (800 to 1200 hp).

Cost for Scenario 2

Total Site Preparation and Disposal	$2,930,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 2*	$5,370,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 3. Rehandling CDF on Waipio Peninsula

Disposal Strategy

Create confined upland disposal area of sufficient capacity to accommodate the anticipated volume of material to be disposed over a 30-year period by dewatering and rehandling desiccated (potentially desalinated) dredged material to 150,000-cubic-yard (10-acre) storage area for subsequent transport to an off-site beneficial use facility or operation. Ideally, the demand for dewatered material would exceed the volume of disposal material and thereby provide a disposal facility of unlimited capacity.

Assumptions

The existing ground within the boundaries of the Waipio site is relatively flat and is suitable to be used as dike construction material. The dike height will be 7 feet above original ground with a minimum top width of 12 feet. Side slopes will be 1 foot vertical on 2 feet horizontal. This estimate covers the expense to prepare the site for long-term use (30 years) with this estimate based on the cost to place, dewater, and rehandle 300,000 gross cubic yards of dredged material. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the off-loading of material barges. The expense of locating and maintaining existing underground utilities within the site area during disposal operations will be covered by increasing the standard contingency factor from 15% to 30%.

Site Parameters/Features

The site is located on the seaward end of Waipio Peninsula which separates Pearl Harbor's West Loch and Middle Loch. Disposal Scenario 3 is similar to the Scenario 2 design but with the addition of dewatering and material recovery features. Based on an assumed dike vertical height of 7 feet, the proposed area would accommodate up to 300,000 cubic yards of material and provide 3 to 4 feet of ponding and freeboard. The site is divided into three areas: two disposal cells for sedimentation and dewatering/desiccation (providing flexibility in operations), and a storage area. All dikes feature a 12-foot-wide compacted top which will provide vehicle access during material placement and rehandling operations. A typical dike cross section will be 7 feet above original ground with a minimum top width of 12 feet with 1-foot vertical on 2-foot horizontal side slopes. Effluent from the settling ponds is directed through two 10-foot horizontal face steel weirs to the receiving water by 160 feet of 4-foot-diameter half culvert. All hardware and structures for effluent discharge are aluminized steel.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material.

Site Preparation. The site preparation estimate is based on employing three D8 class Caterpillar tractors to clear and grub the site and construct the dikes, one 1.75-cubic-yard hydraulic excavator, one 350-hp work boat, and pipe fusing equipment to:

1. Establish a dike foundation "key" about 40 feet wide by 1.5 feet deep.

2. Construct 12,300 linear feet of dike, 7 feet high, by "pushing up" material from within the existing site boundaries in two 3.5-foot lifts. Each lift would be dry compacted by the tractors.

3. Install two 10-foot horizontal face weirs and 160 linear feet of 4-foot-diameter half culvert.

4. Deploy 3000 linear feet (200 feet floating, 2800 feet shore) of 12-inch diameter of neoprene discharge pipe.

Material Disposal Operation. The transit of material from the dredging site and subsequent placement of material within the confined upland site are accomplished in the same manner as that described in Scenario 2. Deployment of shore pipe during the site preparation phase will be such that subsequent shore pipe extensions during the unloading operation will not be required. Effluent treatment during material placement and subsequent dewatering will consist of stilling and mechanical filtering at the weir locations. Dewatering will be accelerated by trenching and harrowing which will be accomplished by employing a low ground pressure (LGP) D7 Cat crawler tractor with hydraulic angle blade.

Material Rehandling Operation. Dewatered material will be stockpiled in the storage area by a LGP D7 Cat. Rehandling of dewatered material for transport to a beneficial-use site will be performed by a single 966 Cat front-end loader.

Major Cost Components for Scenario 3

Site Preparation, Placement, and Dewatering	$2,580,000.00
Rehandling of Dewatered Material	1,140,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 3*	$6,160,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 4. Topsoil Facility, Waipio Peninsula

Disposal Strategy

Create confined upland disposal area of sufficient capacity to accommodate the anticipated volume of material to be disposed over a 30-year period by dewatering and rehandling dredged material to an offsite beneficial-use facility or operation. This scenario calls for essentially the same material placement, dewatering, and rehandling features as described in Scenario 3 with the addition of a process that converts dredged material to soil suitable for agriculture use. The beneficial-use aspect of the soil product will generate an offsite demand for the material and thereby provide optimum or near optimum site capacity for several decades.

Assumptions

The existing ground within the boundaries of the Waipio site is relatively flat and is suitable to be used as dike construction material. The dike height will be 7 feet above original ground with a minimum top width of 12 feet. Side slopes will be 1 foot vertical on 2 feet horizontal. This estimate covers the expense to prepare the site for long-term placement of material (30 years) with this estimate based on the cost to place, dewater, manufacture as soil, and rehandle 300,000 gross cubic yards of dredged material. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the off-loading of material barges. As part of the soil manufacturing process, compost, woody debris and vegetation suitable for processing and application as an organic matter supplement are readily available in sufficient quantities and at no cost to the government. The expense of locating and maintaining existing underground utilities within the site area during disposal operations will be covered by increasing the standard contingency factor from 15% to 30%. The contingency factor for the topsoil manufacturing is 15%.

Site Parameters/Features

The rehandling site is located at the seaward end of Waipio Peninsula which separates Pearl Harbor's West Loch and Middle Loch. Disposal Scenario 4 upland site design is the same as Scenario 3 (i.e. location, shape, dike, storage and dewatering features). Topsoil manufacturing would be performed offsite at any of several locations including the compost facility at Barber's Point.

For the purposes of cost estimating, manufacturing and topsoil storage are assumed to occur at Barber's Point.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material.

Site Preparation. The site preparation estimate is based on employing two D8 class Caterpillar tractors to clear and grub the site and construct the dikes, one 1.75-cubic-yard hydraulic excavator, one 350-hp work boat, and pipe fusing equipment to:

1. Establish a dike foundation "key" approximately 40 feet wide by 1.5 feet deep.

2. Construct 12,300 linear feet of dike, 7 feet high, by excavating "pushing up" material from within the existing site boundaries in two 3.5-foot lifts. Each lift would be dry compacted by the tractors.

3. Install two 10-foot horizontal face weirs and 160 linear feet of 4-foot-diameter half culvert.

4. Deploy 1200 linear feet (200 feet floating, 1000 feet shore) of 12-inch diameter of neoprene discharge pipe.

Material Upland Disposal & Desalinization. The transit of material from the dredging site and subsequent placement of material within the confined upland site are accomplished in the same manner as that described in Scenario 2 or 3. Deployment of shore pipe during the site preparation phase will be such that subsequent shore pipe extensions during the unloading operation will not be required. Effluent treatment during material placement and subsequent dewatering will consist of stilling and mechanical filtering at the weir locations. To reduce the material salinity to an acceptable level, fresh water will be used to reslurry material during the barge unloading operation.

Dewatering. Effluent will be transported back to the harbor through the weir system. Dewatering will be accelerated by trenching and harrowing with a low ground pressure (LGP) D4 size crawler tractor.

Soil Manufacturing Process. Material will be transferred to a "Morebark" type debris grinder for mixing with pulverized compost, vegetation and woody debris 30% by volume and an appropriate amount of lime to balance pH levels. Vegetation and woody debris would be obtained from local sources in need of a disposal outlet for recyclable plant and wood waste. The soil product would be comprised of approximately 50 to 60 % fine-grained dredged material, 10 to 20 % coarse-grained dredged material, and 30 % organics. The facility would feature an onsite woody debris recycle depot or collection station. The Morebark grinder will be tended by two front-end loaders (Cat 966 or similar) and one LGP D-7 size tractor crawler.

Rehandling Operations. The estimate for rehandling of dredged material, organic material, and the topsoil product is based on an average estimated cost of two likely material rehandling scenarios.

1. Single handle -- where there is no immediate need for disposal site capacity and manufacturing is performed continuously, dredged material will be mined directly from the disposal cells and loaded into trucks for transport to the manufacturing facility. Transport of dredged material will occur at the rate required for manufacturing. The topsoil would be transported by truck to the beneficial-use site directly from the Morebark manufacturing conveyor or stored at the manufacturing site until needed.

2. Double handle -- where the need for site capacity is immediate and manufacturing of topsoil is performed intermittently when organic material is available or there is a need for topsoil, temporary stockpiling of fine-grained and coarse-grained dredged material is performed at the disposal site. Transport of dredged material to the manufacturing facility will occur later at the rate required for manufacturing. The topsoil would be transported by truck to the beneficial-use site directly from the Morebark manufacturing conveyor or stored at the manufacturing site until needed.

Major Cost Components for Scenario 4

Site Preparation, Disposal, Dewatering, and Rehandling	$3,140,000.00
Transport/Manufacturing of Topsoil	5,560,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 4*	$11,140,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 5. Reef Runway CDF

Disposal Strategy

Dispose 300,000 cubic yards of dredged material at an upland confined disposal facility (CDF) adjacent to the airfield located immediately east of the Pearl Harbor entrance channel. Dredged material will be transported by barge to an unloading station and off-loaded by reslurry pump. Exposure to sea and swell conditions will limit this operation to fair weather seasons. Material will be transported using two 3000-cubic-yard capacity dump barges and one 2200-hp tug. Site preparation will be accomplished to such extent as to provide capacity for just 300,000 cubic yards despite having a capacity of about one million cubic yards. As such, subsequent disposal operations at this location, if any, would require additional site preparation.

Assumptions

The facility will be constructed as one shallow cell with multiple inlets to spread the material more evenly and a single weir to discharge the effluent. The CDF design is such that the length of the cell will provide for nearly complete sedimentation. The existing ground within the site boundaries is suitable for the construction of containment dikes. No underground utilities exist within the site area. Therefore, no relocation costs will be incurred. However, additional costs will be incurred because a fixed landing/dock is unavailable to mount the discharge pipe. In addition, the site will have greater restrictions and security requirements due to FAA controls. Consequently, the standard contingency factor of 15% was increased to 30%. The average one-way haul distance between the dredging site and the barge off-loading point is 6 nautical miles. The material barge transit speed will average 5 knots.

Site Parameters/Features

The runway upland CDF will consist of an area 5000 feet long by 1000 feet wide enclosed by 12,000 linear feet of containment dikes. The typical sea-side dike section is 40 feet wide at the base, 10 feet high with a 12-foot-wide compacted top (service road), and 1-on-2 side slopes. The runway-side dike section will be built to comply with FAA regulations with 1 on 15 side slopes. The primary cost component of dike construction cost is the assumption that a single CAT D8 tractor can construct a minimum of 150 linear feet of dike in an 8- to 10-hour period. The passage of effluent to the receiving water will be controlled by a 10-foot-wide steel weir. The effluent will be filtered if needed to reduce the suspended solids to acceptable levels prior to release into open water.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material. This cost is addressed as a separate cost for floating plant and mobilization and demobilization of all major pieces of off-road land-based equipment (crawler tractors and crawler-mounted excavator). Mobilization of all other land equipment (tire mounted equipment) is considered incidental to the overall cost of site preparation.

Site Preparation. The site preparation estimate is based on employing three D8 class Caterpillar tractors, one 1.75-cubic-yard hydraulic excavator, one 350-hp work boat, one 2200-hp tug, and pipe fusing equipment to:

1. Construct 12,000 linear feet of dike, 6 feet high, by excavating "pushing up" material from within the existing site boundaries in three 2.0-foot lifts. Each lift would be dry compacted by the crawler tractors. Clearing and grubbing will not be required.

2. Install one 10-foot horizontal face weir and 160 linear feet of 4-foot-diameter half culvert.

3. Deploy 6000 linear feet of 12-inch-diameter neoprene pipe.

Barging and Upland Disposal of Material. The transit of material from the dredging site will be accomplished by employing two 3,000-cubic-yard dump barges and a single 2200-hp tug. Barges will be off-loaded by a barge-mounted reslurry unloader system anchored in approximately 30 feet of water 300 feet offshore from the southwest corner of the runway. The barge unloading station consists of a 12-inch-diameter reslurry pump, an up-water pump, and a lattice boom crane (120- to 140-ton capacity) all mounted on a 4500-ton flat barge. The barge will be secured by an anchor and deck winch system. Dump barge tug service will be subcontracted and paid for on a load-by-load basis. Effluent treatment during material placement and subsequent dewatering will consist of stilling and mechanical filtering at the weir. Considering the high capacity of the site and no requirement to rehandle the material, no special dewatering efforts such as trenching and harrowing will be necessary.

Cost for Scenario 5

Site Preparation and Disposal	$2,870,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 5*	$5,310,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 6. Stabilized Fill Facility, Waipio Peninsula

Disposal Strategy

This alternative provides for immediate dewatering of mechanically dredged material by the addition of stabilizing agents. All handling of the material would be done mechanically, not hydraulically, to minimize the quantity of stabilizing agents needed. The final product would be suitable for structural or non-structural fill.

Assumptions

This estimate covers the expense to stabilize 300,000 gross cubic yards of dredged material. As material is stabilized, it is either stockpiled or removed for use as fill, if a current need exists. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the mechanical off-loading of material barges.

Site Parameters/Features

Stockpiling of material will be on the seaward end of Waipio Peninsula in a 10-acre area. An additional 10 acres would be required for staging the stabilization process.

Disposal Site Preparation and Placement of Material

<u>Mobilize/Demobilize</u>. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material.

<u>Site Preparation</u>. The site preparation estimate is based on employing one D8 class Caterpillar tractor to clear and grub the site.

<u>Material Disposal Operation</u>. The transit of material from the dredging site and subsequent placement of material within the confined upland site is accomplished mechanically by load and haul techniques. Dewatering will be nonexistent because of the mechanical dredging and chemical stabilization techniques being employed.

Material Stabilization Process. The dredged material will be mixed with a portland cement (20% by volume) by means of a mixer and attendant equipment. The mixer system consists of a rotating cylinder fed by a material conveyor and an additive hopper. The input end of the cylinder is higher than the output end which provides for blending of material and additive as the mix travels the length of the barrel to a product conveyor which carries the material to either truck transport or stockpile. The mixer is fed material and additive by two front-end loaders and one D7 LGP tractor. The overall mixing process is mobile enough to move through the disposal area as material is hauled offsite.

Stabilized Material Rehandling Operation. The estimate for rehandling of stabilized fill is based on an average estimated cost of two likely rehandle operations.

1. Single handle -- where there is an immediate need for stabilized material, stabilized fill would be loaded directly from the mixer product conveyor into truck transport. Material would be transported at the same rate that stabilized material is produced and neither stockpiling nor rehandling would be required.

2. Double handle -- where there is not an immediate need for stabilized material, the fill material will be stockpiled and then rehandled when a need for fill arises.

Major Cost Components for Scenario 6

Site Preparation, Rehandling and Stabilization	$14,420,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 6*	$16,860,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 7. Nearshore CDF, Waipio Peninsula

Disposal Strategy

Create confined in-water disposal area by constructing a breakwater enclosure along the eastern shoreline of Waipio Peninsula. The available area, approximately 20 acres, will not provide sufficient capacity to accommodate the anticipated volume of material to be disposed over a 30-year period. The upper limit of disposal capacity for this design is approximately 645,000 cubic yards which is considerably less than the estimated 30-year requirement. Scenario 7 calls for essentially the same material transport and placement procedures as described in Scenario 2. Displaced enclosure water and slurry effluent will be directed through a weir back to the harbor.

Assumptions

The harbor bottom at the containment dike construction site is relatively flat with a suitable foundation material to support the structure. Local material is available for excavation and is suitable for construction of the dike core. Quarry rock (class III riprap) of acceptable quality is available locally. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is ample water depth immediately adjacent to the disposal site that can be used as a staging area for the off-loading of material barges without posing a hazard to navigation. Material will be slurried and pumped into the nearshore CDF which is essentially an in-water environment. As such, and unlike a confined upland facility, it is assumed that the disposed material will flow and disperse evenly and therefore not require multiple discharge pipelines and shore equipment to manage the site as it is filled. Creation of an artificial reef would suffice as an acceptable mitigation project to replace the anticipated loss of productive aquatic habitat as a result of the nearshore CDF operation.

Site Parameters/Features

The site is located on Waipio Peninsula along a 2400-foot stretch of shoreline immediately north of Nevada Point. The shoreline at this site forms a shallow embayment which will be enclosed by the construction of an in-water containment dike. Construction of the nearshore CDF will destroy environmentally valuable habitat. Mitigation is required and is addressed in this estimate as a separate lump sum effort; specifically, the construction of an artificial reef.

Disposal Site Preparation and Disposal of Material

Site Preparation. The nearshore CDF will be established by construction of a 2400-foot-long containment dike. Dike composition will consist of an inner core that is approximately 60 foot wide at the base, 20 foot high, and with a 20-foot-wide top. In phase one of the dike construction, core material will be placed and armored with approximately 4 feet of class III riprap, chinked with pit run stone. Dike core material will be obtained by excavating local material from an upland area immediately adjacent to the south end of the containment dike. Excavation will be accomplished by using a CAT 375 hydraulic excavator (4.75-

cubic yard capacity bucket). Material will be transported to the dike construction site by four 30-cubic-yard-tractor-trailer dump trucks. Armor and chinking stone will be provided by a subcontractor. The estimated riprap and pit run price includes delivery to the jobsite. Placement and compaction of all dike material will be accomplished by one CAT D-8 tractor and one CAT 350L (long reach) hydraulic excavator fitted with a bucket and thumb. The core material borrow pit will be used as part of the sedimentation cell. Excavation of the pit will be located such that minimal trenching would be required to establish input and discharge channels through which the flow of effluent is controlled by two 10-foot-wide steel weirs fitted with tide gates as needed. Site preparation includes the effort to mobilize and station a barge-mounted slurry pump unloader system (see Scenario 2) and deploy approximately 600 feet of 12-inch-diameter neoprene discharge pipeline (450 feet floating, 150 feet shore).

Disposal of Material. Transport of material from the dredging site and final placement into the nearshore CDF will be accomplished using a slurry unloader system as described in Scenario 2 but without the need for multiple discharge pipelines or equipment to insure even dispersal of material.

Major Cost Components for Scenario 7

Site Preparation and Disposal of Material	$5,130,000.00
Site Mitigation	950,000.00
Dredging and Transport	2,440,000.00
Total Estimated Cost, Scenario 7*	$8,520,000.00

* Based on 300,000 cubic yards of in situ sediment dredged.

Scenario 8. Waikele Tunnels

Disposal Strategy

Dispose of dredged material by backfilling 120 abandoned ammunition tunnels. It should be noted that this disposal scenario does not provide for disposal of the base estimate volume of 300,000 cubic yards of dredged material. The process would require barge transport and chemical stabilization of approximately 120,000 cubic yards of dredged material which will be stabilized by introduction of a binder material (20% by volume), producing 144,000 cubic yards of stabilized material. The material will be rehandled and transported to the Waikele tunnel system for final disposal. In addition, the Waikele tunnel complex will also require preparation prior to backfilling. This will involve removal of a concrete baffle feature present at each tunnel. This scenario calls for essentially the same material placement, stabilization, and rehandle features as described in Scenario 6 (Stabilized Fill Facility) with the addition of tunnel preparation and backfilling operations.

Assumptions

This estimate covers the expense to stabilize 120,000 gross cubic yards of dredged material. As material is stabilized, it is transported to the tunnels for use as fill. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the mechanical off-loading of material barges. (Due to the limited capacity of the tunnels, it is assumed that the Waikele complex represents a disposal strategy that is only supplemental to the overall LTMS and that an upland stabilization facility capable of processing a minimum of 300,000 cubic yards would be required.) The material stabilization process applied at the initial off-loading site is sufficient to satisfy contaminant migration concerns at the Waikele tunnel complex. Equipment selected to perform tunnel backfilling will be able to effectively maneuver and place material within the tunnel structures. There will be a demand for the concrete baffle debris removed during the tunnel preparation work as backfill or bank protection material and will not require a disposal fee.

Site Parameters/Features

The initial containment and stabilization site is located at the seaward end of Waipio Peninsula which separates Pearl Harbor's West Loch and Middle Loch. The site design is the same as that for Scenario 6.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob (M&D) all equipment specifically required for the transport, off-loading, and final disposal of material. This cost is broken down into two phases, M&D for equipment needed to off-load, stabilize, and handle material at Waipio Peninsula and M&D for the second phase of work which involves transport and disposal of material at Waikele tunnels.

Site Preparation. The site preparation estimate is based on employing one D8 class Caterpillar tractor to clear the site.

Material Disposal Operation. The transit of material from the dredging site and subsequent placement of material within the confined upland site is accomplished in the same manner as that described in Scenario 6. The transit of material from the dredging site and subsequent placement of material within the confined upland site is accomplished mechanically by load and haul techniques. Dewatering will be nonexistent because of the mechanical dredging and chemical stabilization techniques being employed.

Material Stabilization Process. The dredged material will be mixed with a portland cement (20% by volume) by means of a mixer and attendant equipment. The mixer system consists of a rotating cylinder fed by a material conveyor and an additive hopper. The input end of the cylinder is higher than the output end which provides for blending of material and additive as the mix travels the length of the barrel to a product conveyor which carries the material to either truck transport or stockpile. The mixer is fed material and additive by two front-end loaders and one D7 LGP tractor. The overall mixing process is mobile enough to move through the disposal area as material is hauled offsite.

Stabilized Material Rehandling Operation. The estimate for rehandling of stabilized fill is based on a single handle process where stabilizing and transport of material take place simultaneously. Stabilized fill would be loaded directly from the mixer product conveyor into truck transport.

Major Cost Components for Scenario 8

Site Preparation, Transport and Placement	$1,750,000.00
Material Stabilization and Rehandling	5,770,000.00
Dredging and Transport	980,000.00
Total Estimated Cost, Scenario 8*	$8,500,000.00

* Based on 120,000 cubic yards of in situ sediment dredged.

Scenario 9. Barber's Point Coral Pit CDF

Disposal Strategy

Dispose 390,000 cubic yards of dredged material by filling an existing coral pit by rehandling material from barges using 12-inch hydraulic slurry pumps. The dredged material would then be capped with an additional 43,000 cubic yards of clean dredged material. The process for placement of all material would require barge transport to a new pump-out facility off Barber's Point and then slurrying and pumping with a 12-inch hydraulic dredge pump for final disposal at an existing coral pit. At the final disposal site dewatering and pump-out will be required to stabilize the material. In addition, vertical strip drains will be required to fully dewater the site and permit future land usage. The material will be capped with a minimum 3-foot layer of clean material.

Assumptions

An appropriate pump-out facility in the vicinity of the Coral Pit CDF would be built for anchoring the pipeline for pumping the material from barge to the CDF. The existing condition of the pit interior will require special site preparation, clearing and grubbing, and a dewatering sump. Clean material will be available in sufficient quantity through the normal channel maintenance program at Pearl Harbor to cap the dredged material immediately upon completion of its disposal. No underground utilities exist within the site area. Therefore, no relocation costs will be incurred. However, additional costs will be incurred because a fixed landing/dock is unavailable to mount the discharge pipe. In addition, the site may have some contamination that might require remediation during site preparation. Therefore, the standard contingency factor of 15% was increased to 30%.

Site Parameters/Features

The pit provides approximately 9 acres of disposal area and has an average depth of 30 feet which equates to 435,000 cubic yards of fill capacity. As mentioned above, the method of disposal will be such that strip drains and a effluent pump-out facility will be required at the site. the dredged material will be capped to isolate the dredge material and prepare the site for other uses immediately.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material. This cost is addressed as a separate cost for floating plant and mobilization and demobilization of a crawler-mounted lattice boom crane and LGP crawler tractor. Mobilization of all other land equipment is considered incidental to the overall land transport of material.

Site Preparation. The site requires extensive clearing and grubbing and, if contaminated, may require lining. However, it is assumed to be suitable for immediate placement of material without lining or remediation.

Material Disposal Operation. All material, dredged and capping, will be transported by cycling three low-bulkhead scuppered material barges between the dredging site(s) and Barbers Point in the vicinity of the CDF location.

Material will then be rehandled by 12-inch hydraulic pumps for final disposal in the coral pit. This estimate covers disposal of about 390,000 cubic yards of dredged material and placement of an additional 43,000 cubic yards of capping material for a total disposal volume of 433,000 cubic yards.

Major Cost Components for Scenario 9

Site Preparation and Placement	$5,130,000.00
Dredging and Transport	3,170,000.00
Total Estimated Cost, Scenario 9*	$8,300,000.00

* Based on 390,000 cubic yards of in situ sediment dredged.

Scenario 10. Barber's Point Coral Pit Remediation

Disposal Strategy

Dispose 390,000 cubic yards of dredged material by filling an existing coral pit by rehandling stabilized or dewatered material from Waipio Peninsula by a front end loader to 30-cubic-yard dump trucks. The dredged material will then be capped with an additional 43,000 cubic yards of clean dredged material. The process for placement of all material will require barge transport to a confined upland site on Waipio Peninsula where the material will be off-loaded, dewatered/stabilized, and then rehandled and trucked to an existing coral pit for final disposal. The material will be placed in lifts approximately 4 feet high, compacted, and capped with a minimum 3-foot layer of clean material.

Assumptions

The existing ground within the boundaries of the Waipio site is relatively flat and is suitable to be used as dike construction material. This estimate covers the expense to prepare the site for approximately two disposal operations, the estimated cost to place, dewater, and rehandle 390 cubic yards of dewatered material or 330,000 gross cubic yards of dredged material and an additional 60,000 cubic yards of stabilizing medium plus 43,000 cubic yards of capping material for a total volume of 433,000 cubic yards. The average one-way haul distance between the dredging site and the barge off-loading point is 1.5 nautical miles. The material barge transit speed will average 5 knots. There is an existing shore facility with good water access immediately adjacent to the disposal site that can be used as a staging area for the off-loading of material barges. At the coral pit location, the absence of any immediate potable groundwater source, the existing condition of the pit interior in conjunction with placement of relatively dry material will require only special site preparation (clearing and grubbing). Water treatment or effluent discharge systems will not be required. Clean material will be available in sufficient quantity through the normal channel maintenance program at Pearl Harbor to cap the dredged material immediately upon completion of its disposal. The road system between the Waipio CDF and the coral pit is suitable for truck transport of material.

Site Parameters/Features

The pit provides approximately 9 acres of disposal area and has an average depth of 30 feet which equates to 435,000 cubic yards of fill capacity, approximately 80,000 cubic yards more than is required for this disposal scenario. As mentioned above, the method of disposal will be such that no appreciable amount of water will be introduced into the site during the backfill process, and the dredged material will be capped to provide isolation. Such conditions would not require any site modification to handle effluent discharge or surface water accumulation.

Disposal Site Preparation and Placement of Material

Mobilize/Demobilize. Mob/Demob all equipment specifically required for the transport, off-loading, and final disposal of material. This cost is addressed as a separate cost for floating plant and mobilization and demobilization of all major pieces of off-road land-based equipment (crawler tractors, crawler mounted excavator, and tub mixer). Mobilization of all other land equipment, (tire-mounted equipment) is considered incidental to the overall site preparation and land transport of material.

Material Stabilization and Final Disposal Process. The dredged material will be mixed with a portland cement (20% by volume) by means of a tub or cylinder mixer (a pugmill component) and attendant equipment. The mixer system consists of a rotating cylinder fed by a material conveyor and an additive hopper. The input end of the cylinder is higher than the output end which provides for blending of material and additive as the mix travels the length of the barrel to a product conveyor which loads material directly into trucks for transport to the coral pit. The mixer is fed material and additive by two front-end loaders and one CAT D7 LGP tractor. The overall mixing process is mobile enough to move through the disposal area as material is hauled away. Truck dump gates will be sealed to prevent loss of residual effluent during transport. Two CAT D-7 LGP crawler tractors will be employed at the pit to disperse and compact the material during the placement process and level and compact the capping material. This portion of the overall disposal operation would be based on operating 10 hours per day, 7 days per week.

Major Cost Components for Scenario 10 (Dewatered Material)

Site Preparation, Transport and Placement	$ 2,060,000.00
Dewatering and Rehandling	4,830,000.00
Dredging and Transport	3,170,000.00
Total Estimated Cost, Scenario 10*	$10,060,000.00

* Based on 390,000 cubic yards of in situ sediment dredged.

Major Cost Components for Scenario 10 (Stabilized Material)

Site Preparation, Transport and Placement	$ 2,060,000.00
Stabilization and Rehandling	14,420,000.00
Dredging and Transport	2,680,000.00
Total Estimated Cost, Scenario 10*	$19,160,000.00

* Based on 330,000 cubic yards of in situ sediment dredged.

DETAILS OF COST ESTIMATING
SCENARIOS 1-10 (1998 dollars)

(PRINTOUTS OF SPREADSHEETS)

Dredging & Transport

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Excavate, Load Material into Barges, & Transport in Pearl Harbor

24 Hour Operation
Common Cost, All Scenarios

Component	Quantity/Cost	Unit	Remarks
Bucket Capacity	7	Cubic Yards	
Fill Factor	0.65	Average Bucket	
Working Bucket Cap.	4.55	Cubic Yards	
Bucket Cycle Time	60	Seconds	
Effective Time Factor	0.75	Average Day	Percent of effective time in 24 hour period
Daily Unit	24	Hours	
Daily Effective Time	18	Hours	
Daily Production	4914	Cubic Yards	
Bucket Dredge Rate	$350.00	Per Hour	7 cy Clamshell, Fueled and Operated
Dredge Daily Utilization	24	Hours	
Dredge Cost	$8,400.00	Daily	7 cy Clamshell, Fueled and Operated
Dredge Tender Rate	$72.01	Per Hour	350 hp Dredge Tender/Crew Boat,Op.&Fuel
Tender Daily Utilization	24	Hours	
Tender Cost	$1,728.24	Daily	
Material Barge Rate	$4,000.00	Daily	Two 3,000 cy Material Barges
Tug Service Rate	$350.00	Per Hour	Tug Service
Tug Daily Utilization	8	Hours	
Tug Cost	$2,800.00	Daily	Subcontracted Tug Service
Total Floating Plant Rate	$16,928.24	Daily	Total Direct Costs, Dredging Plant

Dredging & Transport

Contractor Indirect Cost	$8,464.12	50%	50% Contractor Indirect Cost Rate
Total Directs & Indirects	$25,392.36	Daily	Total Contractor Floating Plant Daily Cost
Dredging Duration	61.05	Days	Est. Days to excavate 300,000 gross CY
Subtotal	$1,550,205.13	Job	Est. Excavation Costs, Directs & Indirects
Mobilization & Demob	$250,000.00	Lump Sum	Estimated from previous operations
Subtotal	$1,800,205.13	Job	Excavation with Lump Sum Mob/Demob
Contractor Contingency	$270,030.77	Rate (15%)	Contingencies
Special Equipment	$14,000.00	Lump Sum	DGPS Starlink System and Auto Tide Gage
Subtotal	$2,084,235.90	Job	Estimated Contractor Cost
Government S&A	$312,635.38	Rate (15%)	Gov. Supervision & Administration Cost
Gov. Hydro Surveys	$44,528.00	Lump Sum	Cost for 1 pre and 1 post survey + M&D
Subtotal	$357,163.38	Lump Sum	Estimated Government Costs
Total Dredging Cost	$2,441,399.28	Job	Total Est., Dredging Only, 300,000 CY
Unit Cost	$8.14	Cubic Yard	Excavate and load material barges for transit

Cost Assumptions:

1. Equipment costs for the dredge and dredge tender were based on Portland, Oregon, hourly rental rates (fueled and operated) and increased by 30% to compensate for price differentials (mainly labor & fuel) in Hawaii.

2. Mobilization and Demobilization were extrapolated from previous dredging operations done locally, involved open sea transit, and influenced by the current situation where a capable and properly equipped contractor is located within a few hours of transit time from Pearl Harbor.

Equipment & Production Costs

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

EQUIPMENT COSTS/PRODUCTION COSTS

COMPONENT	**COST**	**UNIT**	**REMARKS**
D8L CAT			Upland Site Preparation, Dike Construction
Base Rental Rate	$87.96	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg. 8)
Universal Hydrauic Blade	$7.95	Hour	EP 1110-1 Region 8
Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total per unit cost	$136.01	Hour	D8L Hourly Rental, Fueled, Op. & Maintained
D4 CAT (Low Ground Pressure)			Upland Disposal Operation, Material Mgmt
Base Rental Rate	$31.29	Hour	Severe Cond. Rate,All Costs Less Op. 1110
Blade and Winch	$11.24	Hour	EP 1110-1 Region 8, Aug. 95
Labor, Operator	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total per unit cost	$82.63	Hour	D4 Hourly Rental, Fueled, Op. & Maintained
BARGE UNLOADER (INLAND)			Package System, Slurry Pump Unloader
624 hp, 12"dia. Pump Platform	$100.56	Hour	DSC BARACUDA 12" EP1110 Region 10
Pump Platform Modifications	$54.82	Hour	Reclaim $75k over 57 days of operation
Griffin Upwater Pump 14500 GPM	$14.03	Hour	110 hp 24" disch (Max.) EP1110 Region 8
4100 Manitowoc	$205.28	Hour	Includes Dep.,Fuel,F.O.G.(EP1110 Reg.10)
Unloader Staging Barge, 160x45	$15.00	Hour	With Spuds, extrapolated from EP1110 R10
Labor, Leverman	$40.45	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Deckmate (Eng./Deckhand)	$39.76	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Crane Operator	$40.82	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Oiler / Rigger	$40.16	Hour	Operator Base+Fringes, Region 10 Davis B
350 hp Tender/Crew Boat, 25ft	$31.90	Hour	Fueled and Maintained, 24hrs Day, Ep1110-10
Total Direct Cost Hourly Rate	**$582.78**	**Hour**	Uploader System, Hourly Cost of Operation

Equipment & Production Costs

FRONTEND LOADER 966 F11 CAT			Material Rehandle Equip., 4.75 cy Bucket
Equipment Base Rate	$83.64	Hour	Severe Condition Rate (1110-1-8) Region 10
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost Hourly Rate	$123.74	Hour	Fueled, Operated, Conventional Bucket
Hydraulic Jaw Bucket	$5.50	Hour	Jaw Bucket Variation for Debris Handling
Total Direct Cost Hourly Rate	$129.24	Hour	Fueled, Operated, with Hydraulic Jaw Bucket
CONVEYOR BELT, KOLMAN			Mdl 101-XHD 20hp, 30"x50', 615 Tons Per Hr
Equipment Base Rate	$10.05	Hour	Severe Condition Rate (1110-1-8) Region 10
Belt Feeder Dozer Trap	$4.20	Hour	Severe Condition Rate (1110-1-8) Region 10
Labor, Operator Helper	$16.24	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost Hourly Rate	$30.49	Hour	Fueled, Operated & Maintained
D-7 LOW GROUND PRESSURE			Work Inside Disposal Cells, Assist FE Load
Equipment Base Rate	$114.25	Hour	Severe Condition Rate (1110-1-8) Region 10
Winch	$8.13	Hour	Winch Listed Separately (1110-1-8) Reg. 10
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost Hourly Rate	$162.48	Hour	D-7 LGP, Fueled, Operated, Maintained
DISCHARGE PIPE DEPLOYMENT			Cost to deploy 120ft. of 12" Dia. Plastic Pipe
Purchase 12" Dia. Plastic Pipe	$932.40	(3) 40' Sec	Purchase New Pipe, 100% Expense this Job
Fuse&Flange (3)40' Sec. 12" Plastic	$248.00	120' Sect.	1 hr; $40 labor, $25 fuser, $10 Gen, $83 D4, Flanges
Deploy (Shore or Floating) 12" Pipe	$291.26	120' Sect.	2 hr; $63 labor, $83 D4 Cat
Total Direct Costs, Acquire & Deploy	$1,471.66	120' Sect.	Use same shore cost for deployment in-water
100 Percent Indirect Cost Rate	$1,471.66	120' Sect.	General & Admin. Overhead, Insurance, etc.
Total Cost, Acquire & Deploy	$4,414.98	120' Sect.	Direct and Indirect Cost Estimate
ESTABLISH LANDING FOR PIPE			
12" Plastic, Floating, Disp. Anchors	$13,244.94	Job	Est. equal expense to deploy 360' of pipe

Equipment & Production Costs

MATERIAL BARGES			Assumed Local and Available
3,000 cy Dump Barge	$2,000.00	Day	Straight Rate, 24 hr. Day, Working or Not
2,000 cy Dump Barge	$1,400.00	Day	Straight Rate, Local Quote, Healy-Tibbitts
4500 Ton Flat Barge (Modified)	$1,250.00	Day	1500cy with Bulkheads & Scuppers Added
			Healy-Tibbits Quote $1.2K Day + $50 Mod
TUG SERVICE			Scenarios Assume Subcontract Tug Service
800 to 2200 hp	$350.00	Hour	Local Quote, Healy-Tibbitts (No break on size)
EXCAVATOR, CAT 325L			Crawler Mounted, 1.75 cy, Long Reach
Base Rental Rate	$60.29	Hour	Includes Dep., Fuel, F.O.G.(EP1110 Reg.10)
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total per unit cost	$100.39	Hour	Hourly Rental, Fueled, Op. & Maintained
EXCAVATOR, CAT 350L			Crawler Mounted, 3.5 cy with grapple, Long R.
Base Rental Rate	$110.24	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
3.5 cy Bucket with Grapple	$6.52	Hour	Double Tine Thumb to Handle & Place Rip Rap
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total per unit cost	$156.86	Hour	Hourly Rental, Fueled, Op. & Maintained
EXCAVATOR, CAT 375			Crawler Mounted, 4.75cy, 428 hp.
Base Rental Rate	$180.62	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total per unit cost	$220.72	Hour	Hourly Rental, Fueled, Op. & Maintained
EFFLUENT WEIR			Riser, Effluent Culvert, Misc. Materials
Riser Unit	$2,485.50	Each	Aluminized 10 Ga. Steel, 10' face, 10' High
Effluent Culvert	$1,260.00	Each	30 ft. 4ft. dia. 10 Ga. Corr. Pipe @ $42/ft.
Miscellaneous Materials	$400.00	LS	Boards, Connect Band, PreMix., Guy Cable
Total Purchase Cost, Base Unit	$4,145.50	Each	FOB to Job Site, Locally Available

Equipment & Production Costs

GOVERNMENT SURVEY COSTS			
M&D 3-Man Hydro Survey Team	$14,179.00	Job	CENWP Survey Team Fully Equiped
2 Day Survey Operation	$5,138.00	Job	Includes Field Work and Final Data Edit
Total	$19,317.00	Job	Min. Cost, NWP Furnish 1 Day Survey Ops
TUB GRINDER, 750 HP MOREBARK			Up to 120 cy per hour, Fully Mobile Plant
Equipment Base Rate	$150.00	Hour	Fueled and Maintained, West Coast Rate
Base Rate Differential	$22.50	Rate	15% Increase, Severe Conditions & POD
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost	$212.60	Hour	Fueled and Operated
TRACTOR TRAILER, 30 CY DUMP	$80.00	Hour	Fueled & Operated, Hawaii Contractor Quote
CONVENTIONAL DUMP TRUCK			Peterbilt Mdl 357, 6x4, 12 CY, 43kGVW
Equipment Base Rate	$49.30	Hourly	Severe Condition Rate (1110-1-8) Region 10
12 cy Dump Box w/ Air Gate	$4.13	Hour	Severe Condition Rate (1110-1-8) Region 10
Operator Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost	$93.53	Hour	Fueled, Operated, and Maintained
TUB MIXER, SINGLE HOPPER			Mat. Mixer, Blend Binders & Additives 300cy hr
Power Tub	$86.25	Hour	Extrapolated Price, 50% Tub Grinder Rate
(2) Kolman Conveyors	$36.04	Hour	1 Loader Belt, 1 Product Belt, Less Operator
Operator, Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Operator Helper, Labor	$16.24	Hour	Laborer Base+Fringes Region 10 Davis B
Total Direct Cost	$178.63	Hour	Fueled, Operated, and Maintained
CLASS III RIP RAP	$30.00	CY	$20 CY West Coast Price, +50% Hawaii
PIT RUN SCREEN	$20.00	CY	$10 CY West Coast Price, +50% Hawaii

Equipment & Production Costs

GEOTEXTILE FABRIC	$1.00	SQ.YD.	Non-woven, Amaco #4555. $.84 +15% Hawaii
DIVE SERVICES	$12,000.00	Day	6-man SSA,Liner Installation, Nearshore CDF
25ft WORK BOAT, MARINE INLAND			Twin Screw with Push Knees
Equipment Base Rate	$31.91	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Operator, Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost	$72.01	Hour	Fueled, Operated, and Maintained
KENT 5000lb Hydra-Hammer	$23.75	Hour	(EP1110 Reg.10) Attachment for CAT325L
DEMOLITION SUPPORT TRUCK			Support CAT 325L Ex. Demo Tunnel Baffels
GMC 2500 1 Ton 4x4 Flatbed	$10.31	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Operator Helper, Labor	$16.24	Hour	Laborer Base+Fringes Region 10 Davis B
Operator Helper, Labor	$16.24	Hour	Laborer Base+Fringes Region 10 Davis B
Rebar and Steel Cutting Equipment	$5.00	Hour	Oxy/Acc Torches(2) Hydraulic Cut. Jaws (1)
Total Direct Cost	$47.79	Hour	Fueled, Operated, Maintained
CAT 916 FRONT-END LOADER			Propane Fueled, Backfill Waikele Tunnels
Base Equipment Rental Rate	$23.06	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Operator, Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
Total Direct Cost	$63.16	Hour	Fueled, Operated, Maintained
MANITOWOC 3900W 140 T CRANE			Crawler Mounted with 5CY Cleanup Bucket
Base Equipment Rental Rate	$138.37	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Operator, Labor	$40.10	Hour	Operator Base+Fringes Region 10 Davis B
5 Cubic Yard Gen.Purpose Bucket	$9.39	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Total Direct Cost	$187.86	Hour	Fueled, Operated, Maintained

Equipment & Production Costs

BARGE UNLOADER (OFF-SHORE)			Package System, Slurry Pump Unloader
624 hp, 12"dia. Pump Platform	$100.56	Hour	DSC BARACUDA 12" EP1110 Region 10
Pump Platform Modifications	$54.82	Hour	Reclaim $75k over 57 days of operation
Griffin Upwater Pump 14500 GPM	$14.03	Hour	110 hp 24" disch (Max.) EP1110 Region 8
4100 Manitowoc	$205.28	Hour	Includes Dep., Fuel, F.O.G. (EP1110 Reg.10)
Unloader Staging Barge, 4500 T Flat	$50.00	Hour	Healy-Tibbits Quote, $1200 per day $50 hr
Labor, Leverman	$40.45	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Deckmate (Eng./Deckhand)	$39.76	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Crane Operator	$40.82	Hour	Operator Base+Fringes, Region 10 Davis B
Labor, Oiler / Rigger	$40.16	Hour	Operator Base+Fringes, Region 10 Davis B
350 hp Tender/Crew Boat, 25ft	$31.90	Hour	Fueled and Maintained, 24hrs Day, EP1110-10
Total Direct Cost Hourly Rate	**$617.78**	**Hour**	Uploader System, Hourly Cost of Operation

Scenario 1

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 1, East Loch Capped CAD Facility

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
24 Hour Site Preparation, 24 Hour Disposal

Cost to Excavate East Loch CAD Facility and Dispose Material at Ocean Site

24 Hour Operation

Component	Quantity	Unit	Unit Price	Amount	Remarks
Bucket Capacity	7	Cubic Yards			
Fill Factor	0.65	Average Bucket			
Working Bucket Cap.	4.55	Cubic Yards			
Bucket Cycle Time	60	Seconds			
Effective Time Factor	0.85	Average Day			Percent of effective time in 24 hour period
Daily Effective Time	20.4	Hours			
Daily Production	5569	Cubic Yards			
Dredging Duration	62.85	Days			Est. Days to excavate 350,000 gross CY
Bucket Dredge Cost	24	Hours	$350.00	$8,400.00	7 cy Clamshell, Fueled and Operated
Tender Cost	24	Hours	$72.01	$1,728.24	350 hp Dredge Tender/Crew Boat,Op.&Fuel
Dump Scow Rate		Daily	$4,000.00	$4,000.00	Two 3,000 cy Dump Scows
Tug Cost	12	Hours	$600.00	$7,200.00	Subcontracted Tug Service
Total Floating Plant Rate		Daily		$21,328.24	Total Direct Costs, Dredging Plant
Contractor Indirect Cost		Rate	50%	$10,664.12	50% Contractor Indirect Cost Rate
Total Directs & Indirects		Daily		$31,992.36	Total Contractor Floating Plant Daily Cost

Scenario 1

Site Preparation/Capping Subtota	62.85	Days	$31,992.36	$2,010,580.69	Est. Excavation Costs, Directs & Indirects
Contractor Contingency		Rate	15%	$301,587.10	Contingencies
Special Equipment		Lump Sum	$14,000.00	$14,000.00	DGPS Starlink System and Auto Tide Gage
Contractor Subtotal		Job		$2,326,167.80	Estimated Contractor Cost
Government S&A		Rate	15%	$348,925.17	Gov. Supervision & Administration Cost
Gov. Hydro Surveys		Lump Sum	$44,528.00	$44,528.00	Cost for 1 pre and 1 post survey + M&D
Government Subtotal		Job		$393,453.17	Estimated Government Costs
Total Disposal Cost		Job		$2,719,620.97	Total Est., Dredging Only, 300,000 CY

Cost Assumptions

1. Equipment costs for the dredge and dredge tender were based on Portland, Oregon hourly rental rates (fueled and operated) and increased by 30% to compensate for price differentials (mainly labor & fuel) in Hawaii.

2. Mobilization and Demobilization are considered in the dredging cost and therefore not included again for site preparation.

Scenario 1

Transport and Disposal of Site Preparation Material to Ocean Site

Component	Quantity	Unit	Unit Price	Amount	Remarks
Material Excavation					
Dredge Plant and Scows*	350000	CY	$7.77	$2,719,620.97	Excavate CAD Site and Dispose Material
Cap Excavation and Placement					
Dredge Plant and Scows*	50000	CY	$7.77	$388,517.28	Excavate and Place Cap Material
Total Estimated Cost	1	Job		$3,108,138.25	Contractor and Government Costs Excavate 350 kcy, Transport & Dispose
Estimated					
DISPOSAL Cost Only	**300000**	**CY**	**$10.36**	**$3,108,138.25**	**Scenario No.1, East Loch Capped CAD Facility**
Estimated					
DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated					
TOTAL Cost	**300000**	**CY**	**$18.50**	**$5,549,537.53**	**Scenario No.1, East Loch Capped CAD Facility**

Scenario 2

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 2, Waipio Peninsula CDF

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
12 Hour Preparation, 24 Hour Placement Operation

Construction Period			**Remarks**
Mobilize	4	Days	Local Contractor, 3 hr sea mob
Prepare Upland Site	24	Days	3 D8's 12hr/day 600' per day + landing
Demobilize	4	Days	Local Contractor, 3 hr sea demob
Total Construction Time	32	Days	Not Including Clearing

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	62	Day	$12,841.72	$796,186.64	Slurry and Pump Material Ashore
Clearing and Grubbing	124	Acres	$1,000.00	$124,000.00	Clearing and Grubbing 124 acre site
D8 Cats (3)	24	Day	$6,528.48	$154,507.36	Construct Ext.Dike and Landing
Excavator, CAT 325L Long Reach	2	Day	$1,000.39	$2,000.78	Install 2 Weirs, 1 ten hour day each
Assemble & Deploy Pipe	25	120'	$4,414.98	$110,374.50	Purchase & Deploy 3000' 12" Pipeline
Riser Unit	2	Each	$2,485.50	$4,971.00	Aluminized 10 Ga. Steel, 10' face, 10' High
Effluent Culvert	12	Each	$1,260.00	$15,120.00	30 ft, 4ft -dia. 10 Ga. Corr. Pipe @ $42/ft
Miscellaneous Materials	2	LS	$400.00	$800.00	Boards, Connect Band, PreMix., Guy Cable
Mob/Demob	1	LS	$100,000.00	$100,000.00	Unloader Equipment Only
Direct Cost Subtotal				$1,307,960.28	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$653,980.14	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$1,961,940.42	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$588,582.13	Apply 30% Contingency to D&I Est.
Contractor Cost Subtotal				$2,550,522.55	Total Estimated Contractor Cost
Government S&A		Rate	15%	$382,578.38	Goverment Supervision and Administration
Total Estimated Cost				$2,933,100.93	Contractor & Government Cost

Scenario 2

Estimated DISPOSAL Cost Only	300000	CY	$9.78	$2,933,100.93	Scenario No. 2, Waipio Peninsula CDF
Estimated DREDGING Cost Only	300000	CY	$8.14	$2,441,399.28	Dredging & Transport
Estimated TOTAL Cost	300000	CY	$17.92	$5,374,500.21	Scenario No. 2, Waipio Peninsula CDF

Scenario 2 - Total

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 2, Waipio Peninsula CDF

Cost Basis: Dredging and Disposal 1,600,000 cy in situ Sediment
12 Hour Preparation, 24 Hour Placement Operation, 5 Projects

Construction Period			**Remarks**
Mobilize	4	Days	Local Contractor, 3 hr sea mob
Prepare Upland Site	24	Days	3 D8's 12hr/day 600' per day + landing
Demobilize	4	Days	Local Contractor, 3 hr sea demob
Total Construction Time	32	Days	Not Including Clearing

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	331	Day	$12,841.72	$4,246,063.35	Slurry and Pump Material Ashore
Clearing and Grubbing	124	Acres	$1,000.00	$124,000.00	Clearing and Grubbing 124 acre site
D8 Cats (3)	24	Day	$6,528.48	$154,507.36	Construct Ext.Dike and Landing
Excavator, CAT 325L Long Reach	2	Day	$1,000.39	$2,000.78	Install 2 Weirs, 1 ten hour day each
Assemble & Deploy Pipe	25	120'	$4,414.98	$110,374.50	Purchase & Deploy 3000' 12" Pipeline
Riser Unit	2	Each	$2,485.50	$4,971.00	Aluminized 10 Ga. Steel, 10' face, 10' High
Effluent Culvert	12	Each	$1,260.00	$15,120.00	30 ft 4ft-dia. 10 Ga. Corr. Pipe @ $42/ft
Miscellaneous Materials	2	LS	$400.00	$800.00	Boards, Connect Band, PreMix., Guy Cable
Mob/Demob	6	LS	$100,000.00	$600,000.00	Unloader Equipment Only
Direct Cost Subtotal				$5,257,836.99	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$2,628,918.50	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$7,886,755.49	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$2,366,026.65	Apply 30% Contingency to D&I Est.
Contractor Cost Subtotal				$10,252,782.13	Total Estimated Contractor Cost
Government S&A		Rate	15%	$1,537,917.32	Goverment Supervision and Administration
Total Estimated Cost				$11,790,699.45	Contractor & Government Cost

Scenario 2 - Total

Estimated DISPOSAL Cost Only	**1600000**	**CY**	**$7.37**	**$11,790,699.45**	**Scenario No. 2, Waipio Peninsula CDF**
Estimated DREDGING Cost Only	**1600000**	**CY**	**$8.14**	**$13,020,796.17**	**Dredging & Transport**
Estimated TOTAL Cost	**1600000**	**CY**	**$15.51**	**$24,811,495.62**	**Scenario No. 2, Waipio Peninsula CDF**

Scenario 3

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 3, Dewatering and Rehandling Facility on Waipio Peninsula CDF

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
12 Hour Site Preparation Schedule, 24 Hour Placement Schedule

Construction Period					**Remarks**
Mobilize	4	Days			Local Contractor, 3 hr sea mob
Upland Site Preparation	19	Days			Dikes, Landing, Weirs
Demobilize	4	Days			Local Contractor, 3 hr sea demob
Construction Time	27	Days			Initial Disposal Op only, No Rehandle
					Does Not Include Clearing

UPLAND SITE PREP & PLACEMENT OF MATERIAL

Component	**Quant.**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	62	Day	$11,072.82	$686,514.84	Slurry and Pump Material Ashore
Clearing and Grubbing	124	Acres	$1,000.00	$124,000.00	Clearing and Grubbing 124 acre site
D8 CATS (2)	19	Day	$2,720.20	$50,518.00	Construct Dikes and Shore Pipe Landing
Assemble & Deploy Pipe	25	120'	$4,414.98	$110,374.50	Purchase & Deploy 3000' 12" Pipeline
Excavator, CAT 325L Long Reach	2	Day	$1,000.39	$2,000.78	Install 2 Weirs, 1 ten hour day ea.
Effluent Weirs	2	Each	$4,145.50	$8,291.00	10' face riser, 30' pipe, misc. material
Effluent Culvert	160	Foot	$42.00	$6,720.00	4' dia. effluent pipe, corr steel
Dewater/Rehandle Management	12	Month	$5,000.00	$60,000.00	30 hrs Month D4 Cat+$2500 Mo. Admin
Mob/Demob	1	LS	$100,000.00	$100,000.00	Unloader Equipment Only
Direct Cost Subtotal				$1,148,419.12	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$574,209.56	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$1,722,628.68	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$516,788.60	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$2,239,417.28	Total Estimated Contractor Cost

Scenario 3

Government S&A		Rate	15%	$335,912.59	Gov. Supervision and Administration
Gov. Land Surveys, Site Boundaries	2	Day	$2,569.00	$5,138.00	POD 3-Man Land Survey Team
Government Cost Subtotal				$341,050.59	
Material Trans. & Place Subtotal				$2,580,467.88	Contractor & Government Cost
REHANDLE DEWATERED MAT.					
(1) CAT 966 FE Loader	200	Days	$1,237.40	$247,480.00	Load 30cy Tractor Trailer Dump Trucks
(1) D7 Cat LGP	200	Days	$1,624.80	$324,960.00	Support Rehandle Eq. Inside Disp. Area
Contractor Direct Costs, Subtotal				$572,440.00	
Contractor Indirect Cost		Rate	50%	$286,220.00	
Contractor Direct & Indirect Cost				$858,660.00	
Contractor Contingency		Rate	15%	$128,799.00	
Contractor Estimated Cost				$987,459.00	
Government S&A		Rate	15%	$148,118.85	
Subtotal, Rehandle Material				$1,135,577.85	Load Material to BU Site
Material Trans. & Place Subtotal				$2,580,467.88	Contractor & Government Cost
Subtotal, Rehandle Material				$1,135,577.85	Load and Transport Material to BU Site
Estimated DISPOSAL Costs Only	**300000**	**CY**	**$12.39**	**$3,716,045.73**	**Scenario No. 3, Dewatering/Rehandling Facility on Waipio Peninsula CDF**
Estimated DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated TOTAL Cost	**300000**	**CY**	**$20.52**	**$6,157,445.01**	**Scenario 3, Dewatering/Rehandling Facility on Waipio Peninsula**

Scenario No. 3-Total

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 3, Dewatering and Rehandling Facility on Waipio Peninsula CDF

Cost Basis: Dredging and Disposal 1,600,000 cy in situ Sediment
12 Hour Site Preparation Schedule, 24 Hour Placement Schedule, 6 Projects

Construction Period			**Remarks**
Mobilize	4	Days	Local Contractor, 3 hr sea mob
Upland Site Preparation	19	Days	Dikes, Landing, Weirs
Demobilize	4	Days	Local Contractor, 3 hr sea demob
Construction Time	27	Days	Initial Disposal Op only, No Rehandle
			Does Not Include Clearing

UPLAND SITE PREP & PLACEMENT OF MATERIAL

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	331	Day	$11,072.82	$3,661,183.64	Slurry and Pump Material Ashore
Clearing and Grubbing	124	Acres	$1,000.00	$124,000.00	Clearing and Grubbing 124 acre site
D8 CATS (2)	19	Day	$2,720.20	$50,518.00	Construct Dikes and Shore Pipe Landing
Assemble & Deploy Pipe	25	120'	$4,414.98	$110,374.50	Purchase & Deploy 3000' 12" Pipeline
Excavator, CAT 325L Long Reach	2	Day	$1,000.39	$2,000.78	Install 2 Weirs, 1 ten hour day each
Effluent Weirs	2	Each	$4,145.50	$8,291.00	10' face riser, 30' pipe, misc. material
Effluent Culvert	160	Foot	$42.00	$6,720.00	4' dia. effluent pipe, corr steel
Dewater/Rehandle Management	72	Month	$5,000.00	$360,000.00	30 hrs Month D4 Cat+$2500 Mo. Admin
Mob/Demob	6	LS	$100,000.00	$600,000.00	Unloader Equipment Only
Direct Cost Subtotal				$4,923,087.92	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$2,461,543.96	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$7,384,631.88	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$2,215,389.56	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$9,600,021.45	Total Estimated Contractor Cost
Government S&A		Rate	15%	$1,440,003.22	Gov. Supervision and Administration
Gov. Land Surveys, Site Boundaries	2	Day	$2,569.00	$5,138.00	POD 3-Man Land Survey Team
Government Cost Subtotal				$1,445,141.22	

Scenario No. 3-Total

Material Trans. & Place Subtotal				$11,045,162.66	Contractor & Government Cost
REHANDLE DEWATERED MAT.					
(1) CAT 966 FE Loader	667	Days	$1,237.40	$824,881.78	Load 30cy Tractor Trailer Dump Trucks
(1) D7 Cat LGP	667	Days	$1,624.80	$1,083,132.30	Support Rehandle Eq. Inside Disp. Area
Contractor Direct Costs, Subtotal				$1,908,014.08	
Contractor Indirect Cost		Rate	50%	$954,007.04	
Contractor Direct & Indirect Cost				$2,862,021.11	
Contractor Contingency		Rate	15%	$429,303.17	
Contractor Estimated Cost				$3,291,324.28	
Government S&A		Rate	15%	$493,698.64	
Subtotal, Rehandle Material				$3,785,022.92	Load Material to BU Site
Material Trans. & Place Subtotal				$11,045,162.66	Contractor & Government Cost
Subtotal, Rehandle Material				$3,785,022.92	Load and Transport Material to BU Site
Estimated DISPOSAL Costs Only	**1600000**	**CY**	**$9.27**	**$14,830,185.59**	**Scenario 3, Dewatering/Rehandling Facility on Waipio Peninsula CDF**
Estimated DREDGING Cost Only	**1600000**	**CY**	**$8.14**	**$13,020,796.17**	**Dredging & Transport**
Estimated TOTAL Cost	**1600000**	**CY**	**$17.41**	**$27,850,981.76**	**Scenario 3, Dewatering/Rehandling Facility on Waipio Peninsula**

Scenario 4

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 4, Manufactured Topsoil Facility

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
10 Hour Trucking and Manufacturing Schedule, 24 Hour Material Placement Schedule
1-hour Round Trip: Loading, Dumping, and Travel Time
Disposal, Dewatering & Rehandling Costs are from Scenario No. 3

Component	Quant.	Unit	Unit Price	Amount	Remarks
TOPSOIL MANUFACTURING PROCESS					Mix 90KCY Organic Additive
Mobilize/Demobilize	1	Job	$50,000.00	$50,000.00	
Tub Grinder System, 100 cy per hr	333	Day	$2,126.00	$707,958.00	West Coast Quote + 15% for SC&POD
D7 CAT, Low Ground Pressure	333	Day	$1,624.80	$541,058.40	Open Access/Tend Grinder within Site
(1)CAT 966 FEL, Straight Bucket	150	Day	$1,237.40	$185,610.00	Handle Dredged Material
(1)CAT 966 FEL,Hydraulic Bucket	200	Day	$1,292.40	$258,480.00	Handle Wood Debris & Dredge Material
Calcium Oxide (Lime)	380	Ton	$155.00	$58,900.00	Add Lime to Balance pH of Wood Deb.
Contractor Direct Cost Subtotal				$1,802,006.40	Topsoil Manufacture Process
Contractor Indirect Cost		Rate	30%	$540,601.92	Indirect Cost Percentage Factor
Direct and Indirect Cost Subtotal				$2,342,608.32	TS Manufacture Est. Directs & Indirects
Contractor Contingency Factor		Rate	15%	$351,391.25	Apply 15% Contingency to D&I Est.
Contractor Cost, T.S. Manufacture				$2,693,999.57	Topsoil Manufacture Process Only
Government S&A, T.S. Manufacture		Rate	15%	$404,099.94	Gov. Supervision & Administration
Topsoil Manufacture, Subtotal				$3,098,099.50	Contractor & Gov. Costs

Scenario 4

MATERIAL DESALINIZATION					Introduce Freshwater During Disposal
Install Freshwater Service	1	Job	$200,000.00	$200,000.00	Min. (2) 6" Local Freshwater Hydrants
TRANSPORT DREDGED MATERIAL AND REHANDLE MANUFACTURED TOPSOIL					
Single Handle Process					Material Loaded Directly into Transport
(3) 30 cy T/T Dump Trucks	333	Days	$2,400.00	$799,200.00	30 cy Trucks by Tub Grinder
Contractor Indirect		Rate	30%	$239,760.00	
Contractor Indirect & Direct Cost				$1,038,960.00	
Conrtactor Contingency		Rate	15%	$155,844.00	
Contractor Estimated Cost				$1,194,804.00	Contingency, Direct & Indirect
Government S&A		Rate	15%	$179,220.60	
Subtotal, Rehandle Manuf. Topsoil				$1,374,024.60	Estimated Cost, Single Rehandle Only
Double Handle Process					Mat. Stockpiled Prior to Transport to BU
(2) Conventional 12 cy Dump Trucks	333	Days	$1,870.60	$622,909.80	Transport Mat. from Tub to Stockpile
(1) CAT 966 FE Loader	333	Days	$1,237.40	$412,054.20	Load Stockpiled Mat. into 30cy TT
(3) 30 cy TT Dump Trucks	333	Days	$2,400.00	$799,200.00	30cy TT Transp. Mat. to Beneficial Use
Contractor Direct Costs, Subtotal				$1,834,164.00	
Contractor Indirect Cost		Rate	30%	$550,249.20	
Contractor Direct & Indirect Cost				$2,384,413.20	
Contractor Contingency		Rate	15%	$357,661.98	
Contractor Estimated Cost				$2,742,075.18	
Government S&A		Rate	15%	$411,311.28	
Subtotal, Double Handle Material				$3,153,386.46	
Single Rehandle Cost				$1,374,024.60	
Double Rehandle Cost				$3,153,386.46	
Average Rehandle Cost				$2,263,705.53	
Manufacture Topsoil	390000	CY		$3,098,099.50	Scenario No. 4 Process & Add Organics
Desalinization Cost	300000	CY		$200,000.00	Scenario No. 4 Desalinate 300000CY
Average Topsoil Rehandle Cost	390000	CY		$2,263,705.53	Scenario No. 4 Average Rehandle Only

Scenario 4

Estimated Manufacturing Costs Only	**390000**	**CY**	**$14.26**	**$5,561,805.03**	**Scenario 4, Manufactured Topsoil Facility**
Estimated Dredged Material DISPOSAL/REHANDLE Costs Only	**300000**	**CY**	**$10.48**	**$3,143,938.52**	**Scenario 3, Dewatering/Rehandling Facility on Waipio Peninsula CDF**
Estimated DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated TOTAL Cost	**300000**	**CY**	**$37.16**	**$11,147,142.83**	**Scenario 4, Manufactured Topsoil Facility**

Scenario 5

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 5, Reef Runway CDF

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
10 Hour Site Preparation, 24 Hour Placement Operation

Construction Period			Remarks
Mobilize	4	Days	Local Contractor, 3 hr sea mob
Prepare Upland Site	19	Days	3 D8's 8hr da. 450' per da. + landing
Demobilize	4	Days	Local Contractor, 3 hr sea demob
Total Construction Time	27	Days	

Component	Quantity	Unit	Unit Price	Amount	Remarks
Unloader, 12" Hydraulic	62	Day	$11,734.02	$727,509.24	Slurry and Pump Material Ashore
D8 Cats (2)	19	Day	$2,720.20	$51,683.80	Construct Ext.Dike and Landing
2200 HP Tug subcontract	62	Day	$1,400.00	$86,800.00	Additional Tug Service
CAT 325L Excavator	1	Day	$803.12	$803.12	Install 10ft Weir with Culvert
Effluent Weirs	1	Each	$4,145.50	$4,145.50	10' Weir with 30' of 4'dia. Culvert
Assemble & Deploy Pipe	50	120'	$4,414.98	$220,749.00	Purchase & Deploy 6000' 12" Pipeline
Post Fill Site Management	12	Month	$2,000.00	$24,000.00	Monitor/Control Effluent Conditions
Mob/Demob Floating Equipment	1	Job	$100,000.00	$100,000.00	Prime Contractor Equipment Only
Mob/Demob Off-Road Shore Equip.	1	Job	$65,000.00	$65,000.00	Prime Contractor Equipment Only
Direct Cost Subtotal				$1,280,690.66	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$640,345.33	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$1,921,035.99	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$576,310.80	Apply 30% Contingency to D&I Est.
Contractor Cost Subtotal				$2,497,346.79	Total Estimated Contractor Cost
Government S&A		Rate	15%	$374,602.02	Goverment Supervision and Administration
Total Placement Cost				$2,871,948.81	Contractor & Government Cost

Scenario 5

Estimated DISPOSAL Cost Only	**300000**	**CY**	**$9.57**	**$2,871,948.81**	**Scenario 5, Reef Runway CDF**
Estimated DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated TOTAL Cost	**300000**	**CY**	**$17.71**	**$5,313,348.09**	**Scenario 5, Reef Runway CDF**

Scenario 6

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 6, Stabilized Fill Material Facility

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
10 Hour Site Preparation, 24 Hour Placement Operation

MATERIAL TRANS. & PLACEMENT — Est. Cost to transport & place mat. upland

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, Mechanical (Crane)	125	Day	$4,200.00	$525,000.00	Mechanically remove material from Barge
Clearing and Grubbing	10	Acres	$1,000.00	$10,000.00	Clearing and Grubbing 10 Acres
Mob/Demob	1	LS	$50,000.00	$50,000.00	Prime Contractor Equipment Only
Direct Cost Subtotal				$585,000.00	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$292,500.00	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$877,500.00	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	15%	$131,625.00	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$1,009,125.00	Total Estimated Contractor Cost
Government S&A		Rate	15%	$151,368.75	Gov. Supervision and Administration
Gov. Land Surveys, Site Boundaries	2	Day	$2,569.00	$5,138.00	POD 3-Man Land Survey Team
Government Cost Subtotal				$156,506.75	
Estimated Disposal Cost				$1,165,631.75	Contractor & Government Cost
Unit Price	300000	CY	$3.89	$1,165,631.75	Scenario 4 Dipsosal Costs Only

Scenario 6

MATERIAL STABILIZATION					Material Stabilization (10 hr day Ops)
Mobilize/Demobilize	1	Job	$50,000.00	$50,000.00	
Tub Mixer System, 300 cy per hour	125	Day	$1,786.30	$223,287.50	West Coast Quote + 15% for SC&POD
Portland Cement	60000	Ton	$90.00	$5,400,000.00	Binder Additive, 20% by Volume Mix
D7 CAT, Low Ground Pressure	125	Day	$1,624.80	$203,100.00	Open Access/Tend Grinder within Site
(2)CAT 966 Front End Loaders	125	Day	$2,474.80	$309,350.00	Handle Dredged Material
Contractor Direct Cost Subtotal				$6,185,737.50	Stabilization Process
Contractor Indirect Cost		Rate	50%	$3,092,868.75	Indirect Cost Percentage Factor
Direct and Indirect Cost Subtotal				$9,278,606.25	Stabilization Est. Directs & Indirects
Contractor Contingency Factor		Rate	15%	$1,391,790.94	Apply 15% Contingency to D&I Est.
Contractor Cost, Stabilization				$10,670,397.19	Material Stabilization Process Only
Government S&A, Stabilization		Rate	15%	$1,600,559.58	Gov. Supervision & Administration
Material Stabilization Process Total				$12,270,956.77	Contractor & Gov. Costs
REHANDLE STABILIZED MATERIAL					Transport to Beneficial Use Site
Single Handle Process					Material Loaded Directly into Transport
(3) 30 cy TT Dump Trucks	125	Days	$2,400.00	$300,000.00	30 cy Trucks Loaded by Tub Grinder
Contractor Indirect		Rate	50%	$150,000.00	
Contractor Indirect & Direct Cost				$450,000.00	
Contractor Contingency		Rate	15%	$67,500.00	
Contractor Estimated Cost				$517,500.00	Contingency, Direct & Indirect
Government S&A		Rate	15%	$77,625.00	
Sub-Total, Rehandle Stabilized Mat.				$595,125.00	Estimated Cost, Single Rehandle Only

Scenario 6

Double Handle Process					Mat. Stockpiled Prior to Transport to BU
(2) Conventional 12 cy Dump Trucks	125	Days	$1,870.60	$233,825.00	Transport Mat. from Tub to Stockpile
(1) CAT 966 FE Loader	125	Days	$1,237.40	$154,675.00	Load Stockpiled Mat. into 30cy TT
(3) 30 cy TT Dump Trucks	125	Days	$2,400.00	$300,000.00	30cy TT Transp. Mat. to Beneficial Use
Contractor Direct Costs, Subtotal				$688,500.00	
Contractor Indirect Cost		Rate	50%	$344,250.00	
Contractor Direct & Indirect Cost				$1,032,750.00	
Contractor Contingency		Rate	15%	$154,912.50	
Contractor Estimated Cost				$1,187,662.50	
Government S&A		Rate	15%	$178,149.38	
Subtotal, Double Handle Material				$1,365,811.88	
Single Handle Cost				$595,125.00	
Double Handle Cost				$1,365,811.88	
Average Rehandle Cost				$980,468.44	
Site Prep. & Material Placement	360000	CY		$1,165,631.75	Scenario 6 Dipsosal Costs Only
Material Stabilize Cost	360000	CY		$12,270,956.77	Scenario 6 Material Stabilization Only
Average Rehandling Cost	360000	CY		$980,468.44	Scenario 6 Average Rehandle Only
Estimated					
DISPOSAL Cost Only	**360000**	**CY**	**$40.05**	**$14,417,056.95**	**Scenario 6, Stabilized Fill Material Facility**
Estimated					
DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated					
TOTAL Cost	**300000**	**CY**	**$56.19**	**$16,858,456.24**	**Scenario 6, Stabilized Fill Material Facility**

Scenario 7

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 7, Wapiao Penninsula Nearshore CDF

Cost Basis: Dredging and Disposal 300,000 cy in situ Sediment
10 Hour Site Preparation, 24 Hour Placement Operation

Construction Period					**Remarks**
Mobilize	4	Days			Local Contractor, 3 hr sea mob
Nearshore Site Preparation	150	Days			Containment Dike and Treatment Pond
Demobilize	4	Days			Local Contractor, 3 hr sea demob

SITE PREP. & MATERIAL PLACEMENT

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	62	Day	$11,072.82	$686,514.84	Slurry and Pump Material Ashore
D8 CAT	150	Day	$2,720.20	$408,030.00	Assist Dike Construction, All Phases
Work Boats(2),Twin Eng.Push Knee	60	Day	$1,120.16	$67,209.60	Assist Installation Geotextile Barrier
Pipeline	5	120'	$4,414.98	$22,074.90	Purchase & Deploy 600' 12" Pipeline
Excavator, CAT 375	100	Day	$2,207.20	$220,720.00	Excavate Dike Core Material
(4) 30 cy TT Dump Trucks	100	Days	$3,200.00	$320,000.00	30cy TT Transport Dike Core Material
Excavator, CAT 350L w Thumb	150	Each	$1,568.60	$235,290.00	Place & Compact Dike Core & All Stone
Effluent Weirs	2	Each	$4,145.50	$8,291.00	10' face riser, 30' pipe, misc. material
Effluent Culvert	80	Foot	$42.00	$3,360.00	4' dia. effluent pipe, corr steel
Class III Riprap (Delivered)	12000	CY	$30.00	$360,000.00	Armor Stone, Containment Dike Const.
Pit Run Stone (Delivered)	6000	CY	$20.00	$120,000.00	Chink Riprap & Cover Liner 1 ft Layer
Mob/Demob	1	LS	$100,000.00	$100,000.00	Prime Contractor Equipment Only
Post-Fill Site Management	12	Months	$2,000.00	$24,000.00	Manage&Monitor Site Until Next Fill Op
Direct Cost Subtotal				$2,575,490.34	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$1,287,745.17	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$3,863,235.51	Total Est. Direct and Indirect Costs
Contingency Factor		Rate	15%	$579,485.33	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$4,442,720.84	Total Estimated Contractor Cost

Scenario 7

Government S&A		Rate	15%	$666,408.13	Gov. Supervision and Administration
Government Hydro Surveys	1	Job	$19,317.00	$19,317.00	NWP Team, Pre-fill Survey, Dike Site
Government Cost Subtotal				$685,725.13	Surveys, Contract Admin, Inspection
Total Site Prep and Placement				$5,128,445.96	Site Preparation and Material Placement
Site Mitigation Cost	1	Job	$950,000.00	$950,000.00	Artificial Reef Const., Derelict Vessels
Estimated Disposal Cost				$6,078,445.96	Contractor & Government Cost
Estimated DISPOSAL Cost Only	**300000**	**CY**	**$20.26**	**$6,078,445.96**	**Scenario 7, Waipio Peninsula Nearshore CDF**
Estimated DREDGING Cost Only	**300000**	**CY**	**$8.14**	**$2,441,399.28**	**Dredging & Transport**
Estimated TOTAL Cost	**300000**	**CY**	**$28.40**	**$8,519,845.24**	**Scenario 7, Waipio Peninsula Nearshore CDF**

Scenario 7 - Total

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 7, Waipio Penninsula Nearshore CDF

Cost Basis: Dredging and Disposal 645,000 cy in situ Sediment
10 Hour Site Preparation, 24 Hour Placement Operation

Construction Period					**Remarks**
Mobilize	4	Days			Local Contractor, 3 hr sea mob
Nearshore Site Preparation	150	Days			Containment Dike and Treatment Pond
Demobilize	4	Days			Local Contractor, 3 hr sea demob
Construction Time	158	Days			Site Preparation and Disposal Material

SITE PREP. & MATERIAL PLACEMENT

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Unloader, 12" Hydraulic	133	Day	$11,072.82	$1,472,685.06	Slurry and Pump Material Ashore
D8 CAT	150	Day	$2,720.20	$408,030.00	Assist Dike Construction, All Phases
Work Boats(2),Twin Eng.Push Knee	60	Day	$1,120.16	$67,209.60	Assist Installation Geotextile Barrier
Pipeline	5	120'	$4,414.98	$22,074.90	Purchase & Deploy 600' 12" Pipeline
Excavator, CAT 375	100	Day	$2,207.20	$220,720.00	Excavate Dike Core Material
(4) 30 cy TT Dump Trucks	100	Days	$3,200.00	$320,000.00	30cy TT Transport Dike Core Material
Excavator, CAT 350L w Thumb	150	Each	$1,568.60	$235,290.00	Place & Compact Dike Core & All Stone
Effluent Weirs	2	Each	$4,145.50	$8,291.00	10' face riser, 30' pipe, misc. material
Effluent Culvert	80	Foot	$42.00	$3,360.00	4' dia. effluent pipe, corr steel
Class III Riprap (Delivered)	12000	CY	$30.00	$360,000.00	Armor Stone, Containment Dike Const.
Pit Run Stone (Delivered)	6000	CY	$20.00	$120,000.00	Chink Riprap & Cover Liner 1 ft Layer
Mob/Demob	1	LS	$200,000.00	$200,000.00	Prime Contractor Equipment Only
Post-Fill Site Management	25	Months	$2,000.00	$50,000.00	Manage&Monitor Site Until Next Fill Op
Direct Cost Subtotal				$3,487,660.56	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$1,743,830.28	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$5,231,490.84	Total Est. Direct and Indirect Costs
Contingency Factor		Rate	15%	$784,723.63	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$6,016,214.47	Total Estimated Contractor Cost

Scenario 7 - Total

Government S&A		Rate	15%	$902,432.17	Gov. Supervision and Administration
Government Hydro Surveys	1	Job	$19,317.00	$19,317.00	NWP Team, Pre-fill Survey, Dike Site
Government Cost Subtotal				$921,749.17	Surveys, Contract Admin, Inspection
Total Site Prep and Placement				$6,937,963.64	Site Preparation and Material Placement
Site Mitigation Cost	1	Job	$950,000.00	$950,000.00	Artificial Reef Const., Derelict Vessels
Estimated Disposal Cost				$7,887,963.64	Contractor & Government Cost
Estimated					
DISPOSAL Cost Only	**645000**	**CY**	**$12.23**	**$7,887,963.64**	**Scenario 7, Waipio Peninsula Nearshore CDF**
Estimated					
DREDGING Cost Only	**645000**	**CY**	**$8.14**	**$5,249,008.46**	**Dredging & Transport**
Estimated					
TOTAL Cost	**645000**	**CY**	**$20.37**	**$13,136,972.09**	**Scenario 7, Waipio Peninsula Nearshore CDF**

Scenario 8

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 8, Waikele Tunnels

Cost Basis: Dredging and Disposal 144,000 cy in situ Sediment
8 Hour Site Preparation, 8 Hour Placement Operation

Construction Period			**Remarks**
Mobilize	4	Days	Local Contractor, 3 hr sea mob
Tunnel Preparation	40	Days	Concurrent Upland Disposal Op
Demobilize	4	Days	Demob Rehandle Crane/Off-road Eq.
Construction Time	8	Days	24 Hr Operation

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
FINAL DISPOSAL					Transport, & Final Disposal
Mobilize/Demobilize	1	Job	$50,000.00	$50,000.00	$50K Land Equipment
(6) 30cy Tractor Trailer Dump Trucks	100	Day	$3,840.00	$384,000.00	Tub Mixer Load Trucks During Stabiliza.
(3) CAT 325L Excavators	40	Day	$2,409.36	$96,374.40	Tunnel Prep. Demolish Concrete Baffles
(3) KENT 5000lb Hydra-Hammer	40	Day	$570.00	$22,800.00	Tunnel Prep. Excavator Hammer Attach
(1) GMC 1 Ton 4x4 Flatbed	40	Day	$382.32	$15,292.80	Demolition Support Truck, Crew & Equip
(1) CAT 966 F11 Front End Loader	20	Hour	$129.24	$2,584.80	Load Baffle Debris for Final Disposal
(6) 30cy Tractor Trailer Dump Trucks	20	Hour	$480.00	$9,600.00	Transp. Baffle Debris for Final Disposal
(6) CAT 916 Front End Loaders	100	Day	$3,031.68	$303,168.00	Backfill Tunnels with Stabilized Material
Contractor Direct Cost Subtotal				$883,820.00	Stabilization & Transp. Direct Costs
Contractor Indirect Cost		Rate	50%	$441,910.00	Indirect Cost Percentage Factor
Direct and Indirect Cost Subtotal				$1,325,730.00	Est. Contractor Directs & Indirects Only
Contractor Contingency Factor		Rate	15%	$198,859.50	Apply 15% Contingency to D&I Est.
Contractor Cost with Contingency				$1,524,589.50	Transport, and Disposal
Government S&A, Stab. & Final Disp		Rate	15%	$228,688.43	Gov. Supervision & Administration
Material Stab.& Final Disp. Subtotal				$1,753,277.93	Contractor & Gov. Costs

Scenario 8

Estimated DISPOSAL Cost Only	**144000**	**CY**	**$12.18**	**$1,753,277.93**	**Scenario 8, Waikele Tunnels**
Estimated Stabilization Cost Only	**144000**	**CY**	**$40.05**	**$5,766,822.78**	**Scenario 6, Stabilized Fill Estimate**
Estimated DREDGING Cost Only	**120000**	**CY**	**$8.14**	**$976,559.71**	**Dredging & Transport**
Estimated TOTAL Cost	**144000**	**CY**	**$60.36**	**$8,496,660.42**	**Scenario 8, Waikele Tunnels**

Scenario 9

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 9, Barbers Point Coral Pit CDF

Cost Basis: Dredging and Disposal 390,000 cy in situ Sediment, 43,000 cy Cap
12 Hour Site Preparation, 24 Hour Placement Operation

TRANSPORT BY BARGE					Transport by Barge to Off-Load Site
Component	**Quant.**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Assemble & Deploy Pipe	100	120'	$4,414.98	$441,498.00	Purchase & Deploy 12000' 12" Pipeline
Excavator, CAT 325L Long Reach	5	Day	$1,000.39	$5,001.95	Install Sump and Weirs, 3 ten hour day
Effluent Weirs	1	Each	$12,436.50	$12,436.50	30' face riser, 30' pipe, misc. material.
Effluent Culvert	160	Foot	$42.00	$6,720.00	4' dia. effluent pipe, corr steel
624 hp, 12"dia. Pump Platform	180	Day	$3,056.00	$550,080.00	DSC BARACUDA 12" EP1110 Region 10
Griffin Upwater Pump 14500 GPM	180	Day	$336.72	$60,609.60	110 hp 24" disch (Max.) EP1110 Region 8
Dewater/Rehandle Management	12	Month	$5,000.00	$60,000.00	30 hrs Month D4 Cat+$2500 Mo. Admin
D8 CAT	5	Day	$2,720.20	$13,601.00	Assist Dike Construction, All Phases
Unloader, 12"Hydraulic	90	Day	$12,841.72	$1,155,754.80	Slurry and Pump Material Ashore
Clearing and Grubbing	9	Acres	$2,000.00	$18,000.00	Clearing and Grubbing 9 acre site
Strip Drains for Dewatering	306000	Feet	$2.00	$612,000.00	Strip Drains for 9 acre site
2200 HP Tug subcontract	90	Day	$2,800.00	$252,000.00	Additional Tug Service
Mob/Demob	1	LS	$250,000.00	$250,000.00	Prime Contractor Equipment Only
Direct Cost Subtotal				$2,287,754.80	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$1,143,877.40	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$3,431,632.20	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	30%	$1,029,489.66	Apply 30% Contingency to D&I Est.
Contractor Cost Subtotal				$4,461,121.86	Estimated Barge Transport Cost
Government S&A		Rate	15%	$669,168.28	Gov. Supervision and Administration
Government Cost Subtotal				$669,168.28	
Transport & Disposal Subtotal				$5,130,290.14	Contractor & Government Cost

Scenario 9

Estimated DISPOSAL Cost Only	390000	CY	$13.15	$5,130,290.14	Scenario 9, Barbers Point Coral Pit CDF
Estimated DREDGING Cost Only	390000	CY	$8.14	$3,173,819.07	Dredging & Transport
Estimated TOTAL Cost	390000	CY	$21.29	$8,304,109.21	Scenario 9, Barbers Point Coral Pit CDF

Scenario 10 - Dewatered

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 10, Barbers Point Coral Pit Remediation (Dewatered Dredged Material)

Cost Basis: Dredging and Disposal 390,000 cy in situ Sediment, 43,000 cy Cap
10 Hour Site Preparation, 10 Hour Placement Operation
Dewatered Material

MATERIAL TRANS. & PLACEMENT					Est. Cost to transp.& place mat. upland
Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Clearing and Grubbing	9	Acres	$2,000.00	$18,000.00	Clearing and Grubbing 9 Acre Site
Mob/Demob	1	LS	$50,000.00	$50,000.00	Prime Contractor Equipment Only
D7 CAT, Low Ground Pressure	200	Day	$1,624.80	$324,960.00	Spread and Compact Material
(4) 30 cy TT Dump Trucks	200	Days	$3,200.00	$640,000.00	30cy TT Transp. Mat. to Beneficial Use
Direct Cost Subtotal				$1,032,960.00	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$516,480.00	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$1,549,440.00	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	15%	$232,416.00	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$1,781,856.00	Total Estimated Contractor Cost
Government S&A		Rate	15%	$267,278.40	Gov. Supervision and Administration
Gov. Land Surveys, Site Boundaries	2	Day	$2,569.00	$5,138.00	POD 3-Man Land Survey Team
Government Cost Subtotal				$272,416.40	
Estimated Final Disposal Subtotal				$2,054,272.40	Contractor & Government Cost

Scenario 10 - Dewatered

Estimated **DISPOSAL Costs Only**	**390000**	**CY**	**$5.27**	**$2,054,272.40**	**Scenario 10, Barbers Point Coral Pit Remediation**
Estimated **DEWATERING Costs Only**	**390000**	**CY**	**$12.39**	**$4,830,859.44**	**Scenario 3, Dewatering/Rehandling Facility on Waipio Peninsula CDF**
Estimated **DREDGING Cost Only**	**390000**	**CY**	**$8.14**	**$3,173,819.07**	**Dredging & Transport**
Estimated **TOTAL Cost**	**390000**	**CY**	**$25.79**	**$10,058,950.91**	**Scenario 10, Barbers Point Coral Pit Remediation (Dewatered)**

Scenario 10 - Stabilized

Planning Cost Estimates for Pearl Harbor LTMS Disposal Scenarios

Scenario No. 10, Barbers Point Coral Pit Remediation (Stabilized Dredged Material)

Cost Basis: Dredging and Disposal 330,000 cy in situ Sediment, 60,000 cy Stabilizing Agent, 43,000 cy Cap
10 Hour Site Preparation, 10 Hour Placement Operation
Stabilized Material

MATERIAL TRANS. & PLACEMENT Est. Cost to transp.& place mat. upland.

Component	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Remarks**
Clearing and Grubbing	9	Acres	$2,000.00	$18,000.00	Clearing and Grubbing 9 Acre Site
Mob/Demob	1	LS	$50,000.00	$50,000.00	Prime Contractor Equipment Only
D7 CAT, Low Ground Pressure	200	Day	$1,624.80	$324,960.00	Spread and Compact Material
(4) 30 cy TT Dump Trucks	200	Days	$3,200.00	$640,000.00	30cy TT Transp. Mat. to Beneficial Use
Direct Cost Subtotal				$1,032,960.00	Contractor Estimated Direct Cost
Indirect Cost Subtotal		Rate	50%	$516,480.00	Indirect Cost Percent Factor
Direct&Indirect Subtotal				$1,549,440.00	Total Estimated Direct and Indirect Costs
Contingency Factor		Rate	15%	$232,416.00	Apply 15% Contingency to D&I Est.
Contractor Cost Subtotal				$1,781,856.00	Total Estimated Contractor Cost
Government S&A		Rate	15%	$267,278.40	Gov. Supervision and Administration
Gov. Land Surveys, Site Boundaries	2	Day	$2,569.00	$5,138.00	POD 3-Man Land Survey Team
Government Cost Subtotal				$272,416.40	
Estimated Final Disposal Subtotal				$2,054,272.40	Contractor & Government Cost

Scenario 10 - Stabilized

Estimated DISPOSAL Costs Only	390000	CY	$5.27	$2,054,272.40	Scenario 10, Barbers Point Coral Pit Remediation
Estimated STABILIZATION Cost Only	390000	CY	$40.05	$14,417,056.95	Scenario No. 6. Stabilized Fill Material Facility
Estimated DREDGING Cost Only	330000	CY	$8.14	$2,685,539.21	Dredging & Transport
Estimated TOTAL Cost	330000	CY	$58.05	$19,156,868.56	Scenario 10, Barbers Point Coral Pit Remediation (Stabilized)

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14. ABSTRACT

The Naval Station (NAVSTA), Pearl Harbor, dredges a number of locations throughout the Pearl Harbor Naval Complex (PHNC) intermittently to maintain harbor operations. Up to the present time of all of the dredged material has been disposed in the ocean. Recent testing of some sediments has indicated that some of the material is unsuitable for ocean disposal because of potential impacts from contaminants present in the sediments. This finding necessitates evaluating other disposal alternatives that are practicable, economical, and environmentally sound and have high public acceptance. These alternatives should provide disposal solutions for the next 30 years and maintain the future viability of naval operations at Pearl Harbor.

Investigations of alternatives require development of a long-term management strategy (LTMS) and evaluation of the environmental effects of various disposal alternatives. This report documents Phase I of a three-phase study to develop a workable LTMS for PHNC. This report includes a review of dredging volumes and frequencies; dredging and disposal equipment and techniques; environmental resources; and capacities, costs, and logistics of potential disposal alternatives. Ten disposal alternatives, including contained aquatic disposal, upland or nearshore confined disposal, and beneficial uses alternatives, are identified for material that is unsuitable for ocean disposal. A screening evaluation of the alternatives was performed to rank the alternatives. Based on the results of this Phase I effort, it is recommended that Phase II be initiated to evaluate the Waipio Peninsula and the Reef Runway disposal alternatives.

15. SUBJECT TERMS

Contaminant	Disposal	Dredging	Management	Sediment
Costs	Dredged Material	LTMS	Pearl Harbor	Waipio

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
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